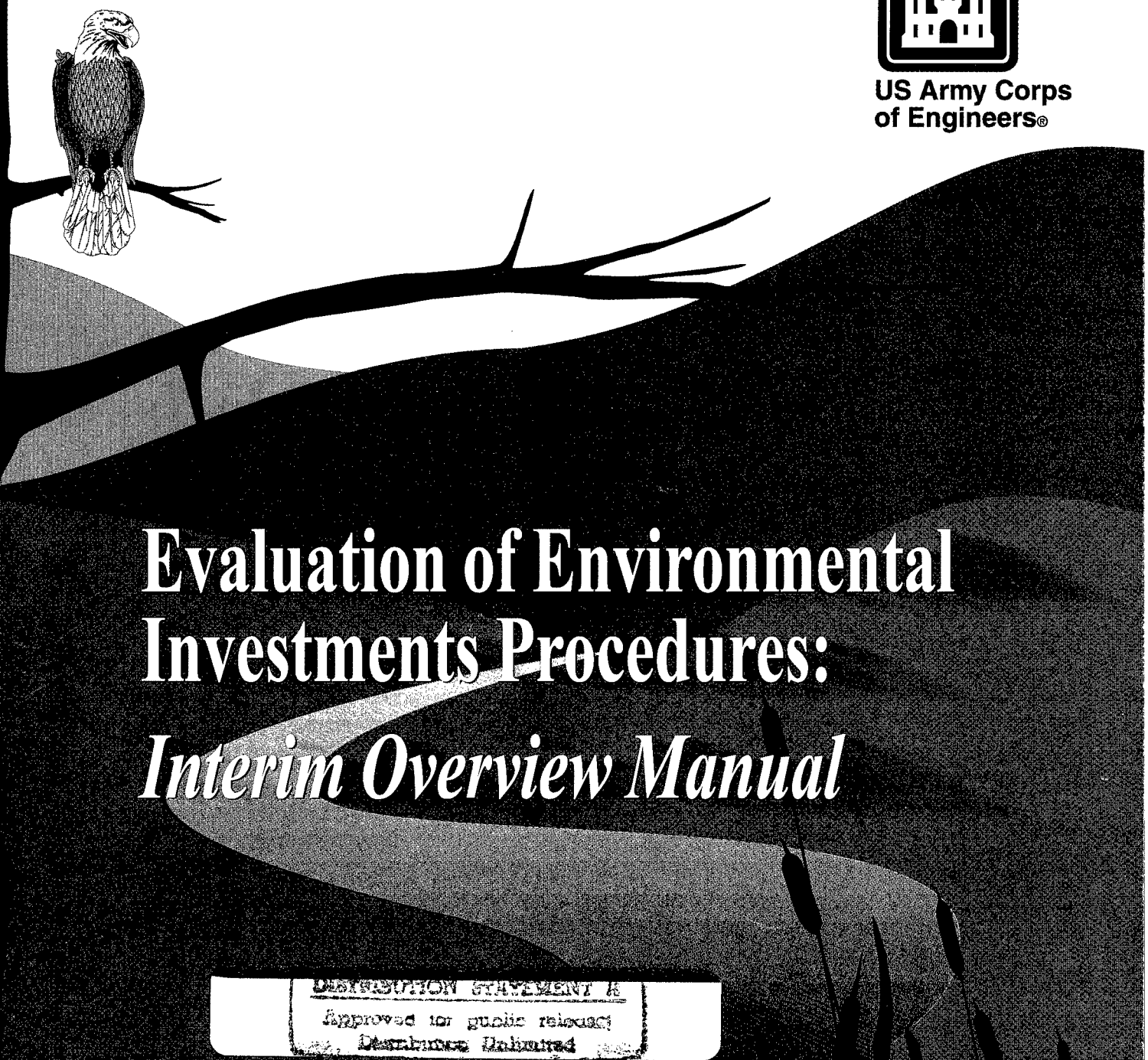

US Army Corps of Engineers®

Evaluation of Environmental Investments Procedures: *Interim Overview Manual*

Evaluation of Environmental Investments Research Program

June 1996
IWR Report 96-R-18

Evaluation of Environmental Investments Procedures

Interim Overview Manual

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PREFACE

This study was conducted as part of the Evaluation of Environmental Investments Research Program (EEIRP). The EEIRP is sponsored by the Headquarters, U.S. Army Corps of Engineers (HQUSACE). It is jointly assigned to the U.S. Army Water Resources Support Center (WRSC) Institute for Water Resources (IWR) and the U.S. Army Engineer Waterways Experiment Station (WES) Environmental Laboratory (EL). Mr. William J. Hansen of IWR is the Program Manager, and Mr. H. Roger Hamilton is the WES Manager. Program Monitors during this study were Mr. John W. Bellinger and Mr. Brad K. Fowler, HQUSACE. The field review group members who provide complete program direction and the District or Division affiliations are as follows: Mr. David Carney, New Orleans District; Mr. Larry M. Kilgo, Lower Mississippi Valley Division; Mr. Richard Gorton, Omaha District; Mr. Bruce D. Carlson, St. Paul District; Mr. Glendon L. Coffee, Mobile District; Ms. Susan E. Durden, Savannah District; Mr. Scott Miner, San Francisco District; Mr. Robert F. Scott, Fort Worth District; Mr. Clifford J. Kidd, Baltimore District; Mr. Edwin J. Woodruff, North Pacific Division; and Dr. Michael Passmore, formerly of Walla Walla District and now at WES. The work was conducted under the Evaluation Framework Unit of the EEIRP. Ms. Joy Muncy of the Technical Analysis and Research Division (TARD), IWR, and Mr. Jim Henderson of the Natural Resources Division (NRD), WES, were the Principal Investigators.

As indicated by the title, this is an *interim* edition of the overview manual. Subsequent revisions and improvements to the manual will be made based on the completion of ongoing research within the EEIRP and on the comments of users of this manual.

The work was performed by Planning and Management Consultants, Ltd. (PMCL) under Task Order No. 23, Contract No. DACW72-94-D-0003 managed by Ms. Joy Muncy. Dr. Timothy D. Feather was the Principal Investigator in collaboration with Dr. Keith Harrington.

The report was prepared under the general supervision at IWR of Mr. Michael R. Krouse, Chief, TARD; and Mr. Kyle E. Schilling, Director, IWR. At EL the report was supervised by Dr. Robert M. Engler, Chief, NRD; Dr. John W. Keeley, Director, EL; and Dr. Robert W. Whalin, Director, WES.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

LIST OF FIGURES

LIST OF TABLES

I. INTRODUCTION

For over a decade the U.S. Army Corps of Engineers (Corps) has actively been involved in environmental restoration projects. As this new direction for the Corps has evolved, it has become increasingly clear that environmental restoration projects pose different planning challenges than traditional water resources development projects. The Evaluation of Environmental Investments Research Program (EEIRP) was initiated by the Corps to develop planning methodologies that respond to these challenges. Specifically, the EEIRP is intended to address what have become known as the "site" and "portfolio" questions:

(1) How can the Corps determine whether the recommended action from a range of alternatives is the most desirable in terms of the environmental objectives?

(2) How should the Corps allocate limited resources among many "most desirable" environmental investment decisions?

The Corps planning process is based upon the U.S. Water Resources Council's *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (*P&G*), promulgated in 1983. The *P&G* provides an evaluation framework that is equally applicable to traditional water resources projects and environmental restoration projects. However, the differences between these projects, such as restoration's predominance of nonmonetary benefits, require tailoring the *P&G* planning process for environmental restoration. The Corps ongoing adaptations of the planning process include: (1) promulgating the various forms of guidance for environmental planning, (2) documenting field experience with planning environmental projects (i.e., case studies), and (3) developing the process and products provided by the EEIRP. This report, prepared under the EEIRP Evaluation Framework work unit, is part of that effort.

PURPOSE

The purpose of this report is to support Corps planners by identifying EEIRP products that can be used to apply the *P&G* planning process to environmental projects. Underlying the incorporation of the EEIRP products in the *P&G* planning process is the need to (1) integrate the tools and techniques identified and developed by the EEIRP and (2) ensure that they collectively address the site and portfolio questions. *(Note: Not all of the EEIRP products have been completed. This interim report highlights the finalized products and outlines those that are in progress. Once all of the products have been completed, this report will be updated and finalized.)*

SCOPE

Corps environmental planning encompasses traditional environmental activities, such as mitigation, and new environmental missions, such as ecosystem restoration. Unless otherwise specified, "environmental planning" refers to ecosystem restoration or mitigation activities. Although the motivations for mitigation and restoration projects can be quite different, their planning processes are virtually identical. Similarly, while the products of the EEIRP are focused on ecosystem restoration, they are also applicable to other environmental contexts, such as cultural resources and hazardous, toxic, and radioactive wastes.

This document is intended to serve as a reference guide for Corps environmental planning. It is a procedures manual that synthesizes the many products of the EEIRP and shows how they can support environmental planning, which is conducted in accordance with the *P&G*. This report does not constitute restoration guidance. It provides an overview of Corps environmental planning and identifies EEIRP products that support specific planning activities. Planners are encouraged to obtain copies of the EEIRP products that pertain to their specific planning challenges. For this reason, an order form to obtain copies of EEIRP products is included at the end of this report.

Since its inception in 1993, the EEIRP has endeavored to capture the state of the art in environmental planning. There are similar programs ongoing in other Federal agencies. There has been considerable communication between these programs as the Federal government refines its environmental decision-making tools. This cross-fertilization shares successes and setbacks and attempts to avoid duplication of research on environmental evaluation.

REPORT CONTENTS

An overview of the institutional setting for Corps environmental planning is presented in the following chapter (II). This overview introduces pertinent guidance, funding authorities, and typical planning partner relationships among other important parameters. Chapter III identifies analytical tools developed through the EEIRP that can be used to support restoration planning. It is organized using the six steps of the *P&G* planning process. Chapter IV discusses how the planning challenges of restoration projects are compounded at the portfolio level and identifies ways in which the EEIRP products can help make difficult portfolio decisions. The last chapter (V) summarizes this report.

II. INSTITUTIONAL SETTING FOR CORPS ENVIRONMENTAL PLANNING

INTRODUCTION

This chapter overviews the current institutional setting within which Corps ecosystem planning is conducted, as well as the process and products of the EEIRP. It is organized into four sections that describe (1) the *P&G* planning process as it has been applied to traditional water resources development projects, (2) the differences between environmental projects and traditional water resources projects, (3) the ecosystem restoration guidance, EC 1105-2-210, and (4) the process and products of the EEIRP.

P&G PLANNING PROCESS: TRADITIONAL WATER RESOURCES PROJECTS

The *P&G* is the centerpiece of Corps planning guidance. It provides the philosophical and procedural foundations for the development of detailed planning methodologies outlined in other guidance. The six-step planning process of the *P&G* provides the structure for ecosystem restoration planning.

The six steps of the *P&G* planning process are illustrated in Figure 1. These steps follow a rational sequence of activities from identification of problems and opportunities to selection of a recommended solution. Underlying the general flow of activities from the first step to the last are analytical iterations: iterations within each step, as well as iterations of the entire process. The following discussions summarize the planning process as applied to traditional water resources projects (e.g., flood control and navigation). This will be followed by discussions of how restoration projects differ from traditional water resources projects, and how these differences can be accommodated within the *P&G* planning process with the help of the products of the EEIRP.

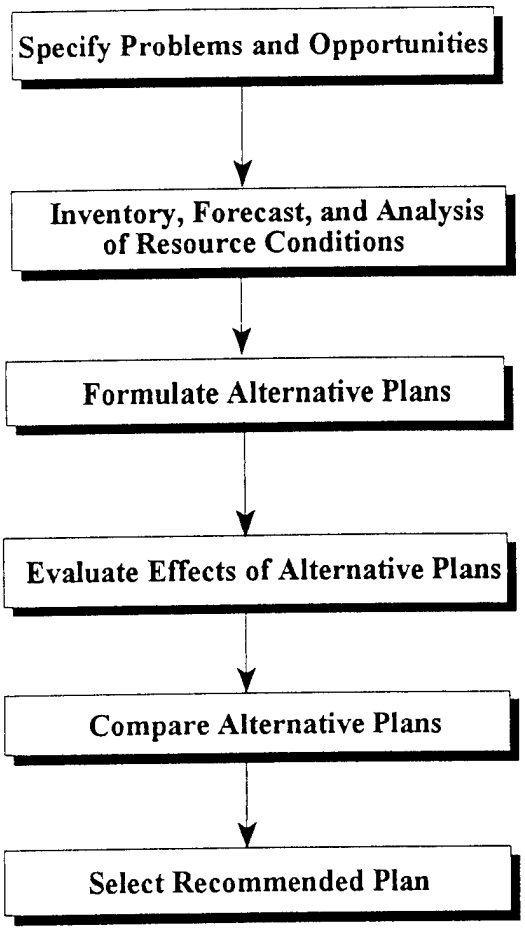

FIGURE 1
P&G PLANNING PROCESS

Specification of Problems and Opportunities

The first step of the planning process is to identify problems and opportunities. During this step, the statement of problems and opportunities is developed. In addition, project scoping activities are initiated in this step, including delineating the planning area, determining the period of analysis, and scoping the project objectives and constraints. At this initial phase of the project, it is particularly important that (1) project partners recognize their responsibilities, (2) stakeholders be identified, and (3) a public involvement program be initiated.

Inventory, Forecast, and Analysis of Conditions

The second step of the planning process is to anticipate the future conditions of the project area through a defined period of analysis. The emphasis of this effort is on forecasting the "without-project" condition. These forecasting activities have many challenges, including those of data collection and management. The planning analyses in this step develop a comprehensive picture of the future site conditions if no action is taken, focusing on the future conditions related to problems and opportunities identified in the previous step.

Formulation of Alternative Plans

The third step of the planning process converts remedial strategies into alternative plans. The formulation of alternative plans is an iterative process that considers the location, dimensions, materials, and timing of the alternatives. The *P&G* specifies that structural and nonstructural plans are to be considered. In addition, mitigation plans are developed as part of the formulation of alternatives, if necessary.

Evaluation of the Effects of Alternative Plans

In the fourth step, alternative plans are evaluated. This step includes assessment and appraisal of alternative plans. There are assessments of (1) the differences between the with- and without-project futures, (2) the effectiveness of meeting project objectives, and (3) project effects. Other assessments consider the completeness, effectiveness, efficiency, and acceptability of alternative plans. These assessments are followed by appraisals of the significance of project effects, including institutional, political, social, technical, financial, economical, and environmental feasibility.

Comparison of Alternative Plans

In the fifth step of the planning process, positive and negative effects of alternative plans are compared. For traditional water resources projects, it is in this step that the plan that maximizes net national economic development (NED) benefits is identified, leading to a single "optimal" solution for the planning objectives.

Selection of a Recommended Plan

In the final step of the planning process, the recommended plan is selected. Among the alternatives considered is the no-action plan. For traditional water resources projects, the NED account comprises the most important decision criteria. As a result, a water resources development plan recommending Federal action must be the NED plan, unless there is an overriding reason to select some other plan.

CHALLENGES OF ENVIRONMENTAL PROJECTS

Environmental projects have important differences from traditional water resources development projects — differences that challenge the traditional planning process and that are critical determinants of the process and products of the environmental planning effort. They can directly and indirectly influence Corps effectiveness in addressing the environmental problem and Corps efficiency in planning and implementing the project. While each project has unique features, the important differences in environmental projects include the relative importance of (1) ecosystems, (2) benefits measured in many metrics, (3) stakeholders.

Ecosystem Evaluation

In contrast with traditional water resources projects, environmental projects are oriented toward ecosystems rather than national economic development. For example, environmental projects are not usually oriented toward some aspect of human safety or welfare as are traditional water resources development projects, which have some aspect of national economic development as their primary purpose.

The objectives and outputs of restoration projects are also more dependent on the ecosystem's structure and function. The individuality of ecosystems challenges the application of standardized planning procedures to restoration projects. Since they focus on ecosystem structures and functions, the value of restoration activities cannot be directly measured in monetary terms. However, at both the site and the portfolio scales, there is a need to evaluate the potential of a plan to meet the project objectives (i.e., effectiveness) with a limited allocation of resources (i.e., efficiency). These effectiveness and efficiency considerations challenge traditional planning methodologies, which were intended to assess in monetary terms the costs and benefits of alternative plans. In addition, determining the significance of a resource is fundamental to defining the environmental problem and setting planning objectives. These activities can be very difficult if an evaluation standard is absent.

Another distinction of environmental projects is derived from the complexity of the project ecosystem. In some cases, the ability to predict ecosystem responses to different inputs and

conditions associated with alternative restoration measures is less evolved than the engineering analyses that typify traditional water resources development projects.

Benefits Measured in Many Metrics

The most important differences between restoration projects and traditional water resources projects are that the benefits of restoration are often measured in many metrics, not simply dollars. While the costs of ecosystem restoration can usually be estimated in dollar values with little difficulty, restoration benefits can be much more challenging. Some restoration benefits, such as recreation, may be measurable given adequate funding and time. However, the outputs of restored ecosystems are typically described in ecological terms, such as habitat units. While there are accepted techniques, for example, the Habitat Evaluation Procedure, to estimate ecosystem outputs, it can be difficult to monetize restoration benefits by estimating human valuation of those outputs.

The nonmonetary benefits of restoration projects challenge planning methodologies that were developed to assess and compare the costs and benefits of alternative plans using the NED account. Environmental decision making is often forced to rely on subjective, rather than objective, measures of efficiency and effectiveness. In addition, there is no longer a single-decision criteria — the maximization of net NED benefits — in the absence of a common metric for costs and benefits. The planning implications of benefits measured in nonmonetary terms have stimulated active research programs in environmental evaluation for several decades, including the EEIRP.

Stakeholders

A stakeholder is someone with something to lose or gain from a recommended course of action. They may be government agencies, private organizations, economic or environmental interest groups, or concerned citizens. While stakeholders can play important roles in planning water resources development projects, they may even be more critical to the success of restoration planning. Some stakeholders have extensive experience with restoration projects that can support Corps planning efforts. Others can share their knowledge of the site or the specific ecosystem. In addition, the difficulty of monetary valuation of restoration benefits raises the significance of stakeholders' valuation of restoration alternatives. While stakeholders are typically not needed to identify the NED plans of water resources projects, they can be very helpful in describing the benefits of restoration alternatives.

ECOSYSTEM RESTORATION GUIDANCE

Corps ecosystem planning guidance directs planners toward specific tools and techniques for use in environmental projects. As in the case of traditional water resources planning, these procedures are often standardized to promote effective site planning for particular projects and consistent methodologies across the Corps portfolio of environmental projects. This guidance includes planning requirements, recommendations, and options. The guidance is transmitted downward through the Corps hierarchy through a diverse series of mechanisms consisting of including: engineering regulations, engineering circulars (ECs), engineering technical letters, engineering pamphlets, various policy guidance letters (PGLs), policy memos, and training programs.

Corps environmental guidance includes a mixture of established information from traditional environmental activities and freshly minted regulations and tools for new ecosystem planning activities. For example, the Corps has a long history with the mitigation of adverse environmental effects of its Civil Works projects. As a result, the guidance for these activities are well developed and well known. In contrast, the ecosystem restoration mission of the Corps is a relatively new mission, and the associated guidance is still under development.

The current ecosystem restoration guidance is *Ecosystem Restoration in the Civil Works Program* (EC 1105-2-210). The purpose of this June 1995 engineering circular is to ensure that restoration projects (1) produce the intended beneficial effects, (2) are cost effective, and (3) are consistent with administration policy.

EC 1105-2-210 clarifies previous guidance on ecosystem restoration. This EC notes that Civil Works budget guidance assigns funding priority to restoration projects (see EC 11-2-163). As in the case of previous restoration guidance, EC 1105-2-210 emphasizes projects that restore environmental degradation to which a Corps project contributed or situations where modification of a Corps project can accomplish the restoration most cost effectively. Emphasis is placed on engineering measures to achieve the restoration objectives. In addition, hydrologic control rather than land acquisition is emphasized. EC 1105-2-210 specifically reasserts previous requirements (PGL No. 24) that the last increment of benefit exceed in value the last increment of cost. While this specification may be difficult to accomplish in many cases, it does identify incremental analysis as an important planning tool.

Ecosystem restoration projects are formulated in the same manner as traditional water resources development projects. EC 1105-2-210 states that "Ecosystem restoration studies differ from traditional projects only in that not all benefits are monetized."

The *P&G* mandates selection of the NED plan except when there are other overriding considerations such as Federal, state, tribal, local, and international concerns. EC 1105-2-210 releases restoration projects from this mandate. It stipulates there is no need to exhibit net NED benefits, but costs should be registered in the NED account. The anticipated value of the outputs

of an ecosystem restoration is the principal measure of the plan's worthiness. Since benefits will be expressed in monetary and nonmonetary units, a benefit-cost ratio is not expected. Other than these responses to the challenges of environmental projects, environmental planning should follow the planning process outlined in the *P&G*.

EEIRP: THE SEARCH FOR ENVIRONMENTAL PLANNING TOOLS

The ecosystem planning guidance, EC 1105-2-210, describes the Corps restoration philosophy and policy. For some planning activities, such as cost effectiveness analysis, there is clear direction for applying specific tools or techniques. For other activities, such as the incorporation of risk and uncertainty into restoration planning, the direction is less clear. This absence is both an opportunity and a hazard. On one hand, the lack of recommended methodologies is an opportunity in that it gives Corps planners flexibility in developing and conducting environmental studies. On the other hand, the absence may leave planners without guidance for those activities, and consistency between projects could suffer. Furthermore, interpretation of this guidance among planners and reviewers may differ. The EEIRP was initiated to help environmental planners operationalize the ecosystem restoration guidance.

Technical Work Units

The nine technical work units of the EEIRP were designed to facilitate ecosystem restoration planning by providing planners with analytical tools and techniques. Figure 2 illustrates how the nine EEIRP work units were affiliated with the six steps of the planning process when the EEIRP was initially formulated. In the realities of project planning, the edges between the six steps blur with iterative loops through the process. Similarly, the boundaries of the work units are much less defined than depicted in this figure.

The objectives and activities of each work unit are characterized below. The work unit descriptions are intended to present the structure and goals of the research in order to (1) connect the research process and products to the philosophical and policy base of the guidance and (2) begin to trace how the tools and techniques developed through the program fit into the six steps of the planning process.

Determining and Describing Environmental Significance

The significance work unit has been developing methods to determine and describe institutional, technical, and public significance. Various ranking and weighting scales for determining, prioritizing, and describing levels of significance are being evaluated in this work unit.

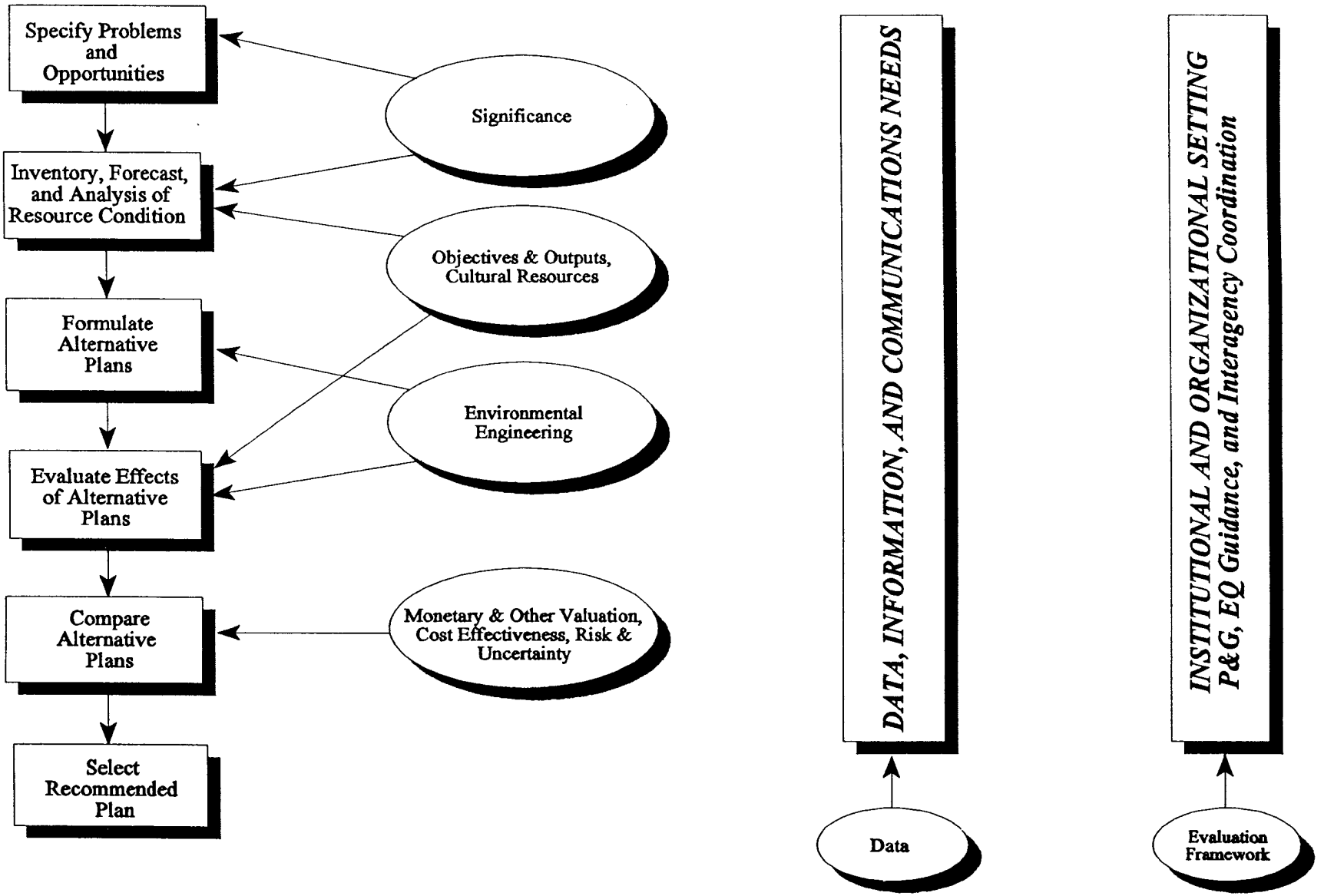

FIGURE 2
EEIRP TECHNICAL WORK UNITS AND THE *P&G* PLANNING PROCESS

Degradation of environmental resources may be more difficult for the public and decisionmakers to recognize than traditional water resources problems. Thus, this work unit is developing guidelines for communicating significance at the local (project), regional, and national levels, which will include an assessment of the scarcity of the resources.

Determining Objectives and Measuring Outputs

The objectives and outputs work unit has been designed to provide guidance on how to establish clear, realistic objectives for environmental restoration projects and develop improved techniques for clearly measuring outputs that are appropriate for those objectives. As part of these efforts, this work unit is investigating the roles ecosystem models can play in the planning process. The intention is to broaden the scope of restoration planning from univariate concerns, such as the focus on individual species, to a more holistic ecosystem perspective. There are additional considerations that this work unit is addressing, including spatial and temporal scales of analyses, adaptive management, and the challenges that arise when the ecosystem extends beyond the restoration site boundaries.

Objective Evaluation of Cultural Resources

The cultural resources work unit is conducting a review of the literature and practice of cultural resource evaluation. A pilot procedure for employing a quantitative/statistical approach to cultural resource evaluation is under development. This will be field-tested with data from a region of northern New Mexico using a combination of research and information management tools.

Engineering Environmental Investments

The engineering work unit is identifying appropriate techniques for engineering restoration projects. This includes development of methods to assess the effectiveness of alternative approaches in producing the intended effects, formulating and estimating costs of project features, and monitoring. Underlying the ultimate formulation of engineering procedures for restoration projects is the intention to focus on standardized procedures, not solutions. Techniques are based on the principles of ecosystem management and the unique requirements of each project.

Cost Effectiveness Analysis Techniques

The cost effectiveness work unit is developing analytical techniques for performing cost effectiveness and incremental cost analyses. Recognizing the limitations of traditional benefit-cost analysis for environmental planning, cost effectiveness and incremental cost analyses are valuable decision-making tools for environmental investments. Cost effectiveness ensures that the least-cost solution is identified for each possible level of environmental outputs. Subsequent incremental cost analysis reveals changes in costs for increasing levels of outputs. Neither cost effectiveness nor incremental cost analyses will guarantee the identification of an optimal solution. However, they provide information that decisionmakers may use to facilitate and support the selection of a single solution.

Monetary and Other Valuation Techniques

The monetary and other valuation techniques work unit is researching methods to identify use and nonuse values associated with outputs from environmental projects. This includes clarifying the linkages between environmental outputs and human services and assessing how stakeholders perceive and value environmental restoration projects. In addition, techniques for monetary valuation are being researched. This work unit's challenge is to provide decisionmakers with value-inclusive information about project benefits to assist them in determining the relative worth of alternative plans or projects.

Incorporating Risk and Uncertainty into Environmental Evaluation

This work unit is focusing on identifying generic and specific sources of risk and uncertainty in environmental restoration planning. For example, how well will the restoration project perform? Is there any uncertainty about the accuracy of the data or the models used to predict project outputs? What are the risks of the project not succeeding? Once identified, potential tools and methods are presented to address these risk and uncertainty issues. Approaches for incorporating risk and uncertainty considerations into environmental evaluations will be demonstrated through a representative case study.

Environmental Databases and Information Management

The environmental databases and information management work unit is developing and implementing concepts for improving communication and dissemination of information to Corps environmental planners. This includes two main thrusts. In the first, a prototype decision support

system (Integrated Bio-Economic Planning System - IBEPS) is being developed which links environmental output models and incremental cost analysis together with spatial data input and handling capability via a geographic information system (GIS). This will be a working product directly usable by planners, and it will demonstrate the utility of computer-aided decision support systems. In the second, EEIRP products will be summarized and made accessible through a World Wide Web site. This will enable those with interests in the environmental restoration process to quickly access information specifically relevant to their project.

Evaluation Framework

This Interim Report focuses on integrating the products of the other EEIRP work units into the six-step planning process of the *P&G*. As part of this effort, this work unit conducted a series of case studies of Corps and non-Corps restoration projects. These case studies were supplemented by research efforts to identify trade-off processes to balance competing interests and examine group processes to elicit the perspectives of project stakeholders. This work unit is currently considering alternative formats and techniques for presenting EEIRP products on the Internet, creating a "virtual" document.

Alignment of EEIRP Products with the Six Planning Steps

The EEIRP is generating a wide array of products. Some of these products are primarily background materials, including literature reviews, workshop proceedings, and case studies. The EEIRP has been using this background research, conducted in the early phases of the program, as a foundation for ongoing development of specific tools and procedures for restoration planning.

The products of each EEIRP work unit are presented in Table 1. Since some of the report titles are cumbersome, abbreviated titles for the products are included in this table and will be used throughout the remainder of this text. Annotations of the products of the EEIRP are found in Appendix A. The work units were a vehicle to conduct supporting research and develop practical tools and techniques for environmental planners. From this point onward in this report, the products of the work units will be generalized to be products of the EEIRP.

Table 1 also illustrates the alignments of the EEIRP products with the six steps of the *P&G* planning process. Connections could be drawn between any of the products and each of the six steps of the *P&G*. However, the alignments shown in this table represent direct associations of products with planning steps. Some of the EEIRP products are completed; others are ongoing or planned.

As shown in Table 1, the EEIRP has a balanced coverage of the six planning steps. In general, significance products are critical in the early steps; ecosystem models and environmental engineering are most important in the middle steps; and cost effectiveness and incremental cost

analyses are the highest priorities in the final steps. There are other products that are applicable virtually throughout the planning process. Some of these will become resonant themes in this report, including issues of stakeholder participation in the planning process, the different types of trade-off analyses, and the various sources of risk and ways to address them. Others among this group, such as the anticipated World Wide Web home page, can be noted as applying to all six steps without extensive discussion.

TABLE 1
ALIGNMENT OF EEIRP PRODUCTS
WITH THE SIX *P&G* PLANNING STEPS

EEIRP WORK UNIT	EEIRP PRODUCTS *(Abbreviated Title)*	1 Specify Problems & Opportunities	2 Inventory & Forecast of Conditions	3 Formulation of Plans	4 Evaluation of Effects	5 Comparison of Plans	6 Plan Selection
DETERMINING AND DESCRIBING ENVIRONMENTAL SIGNIFICANCE	*Resource Significance: A New Perspective for Environmental Project Planning (Significance: New Perspectives)*	●	●				
	Significance for Environmental Project Planning: Resource Document (Significance: Resource Document)	●	●				
	Significance Protocol Worksheet — Draft *(Significance: Protocols)*	●	●				
DETERMINING OBJECTIVES AND MEASURING OUTPUTS	*Restoration Analysis: Use of Models to Predict Restoration Success* — Draft *(Restoration Analysis)*		●	●			
	Identifying and Examining Parameters for Environmental Restoration Projects — Draft *(Restoration Parameters)*		●	●			

TABLE 1 (Continued)
ALIGNMENT OF EEIRP PRODUCTS
WITH THE SIX *P&G* PLANNING STEPS

		1	2	3	4	5	6
EEIRP WORK UNIT	**EEIRP PRODUCTS** *(Abbreviated Title)*	**Specify Problems & Opportunities**	**Inventory & Forecast of Conditions**	**Formulation of Plans**	**Evaluation of Effects**	**Comparison of Plans**	**Plan Selection**
OBJECTIVE EVALUATION OF CULTURAL RESOURCES	*Trends and Patterns in Cultural Resource Significance: An Historical Perspective and Annotated Bibliography* — Draft *(Cultural Resource Significance: Trends and Patterns)*	●					
	Evaluating Cultural Resources Significance: New Directions in Theory and Practice, Proceedings of a Corps of Engineers Workshop — Draft *(Cultural Resource Significance: New Directions)*	●					
	Operationalizing Regional Models for Significance Evaluation: An Assessment of the Practice of Significance Evaluation and A GIS Case Study — Draft (Cultural Resource Significance: Regional Models)		●		●		

TABLE 1 (Continued)
ALIGNMENT OF EEIRP PRODUCTS
WITH THE SIX *P&G* PLANNING STEPS

EEIRP WORK UNIT	EEIRP PRODUCTS *(Abbreviated Title)*	1 Specify Problems & Opportunities	2 Inventory & Forecast of Conditions	3 Formulation of Plans	4 Evaluation of Effects	5 Comparison of Plans	6 Plan Selection
ENGINEERING ENVIRONMENTAL INVESTMENTS	*Prototype Information Tree for Environmental Restoration Plan Formulation and Cost Estimation (Information Tree)*			●			
	National Review of Non-Corps Environmental Restoration Projects — Draft *(Non-Corps Restoration)*			●			
	National Review of Corps Environmental Restoration Projects — Draft *(Corps Restoration)*			●			
	Aquatic Restoration Monitoring: Guidelines for Planning, Implementation, and Management of Monitoring Programs — Draft *(Monitoring Guidance)*			●	●		
	Procedures Manual: Engineering for Environmental Restoration — Anticipated *(Engineering Procedures Manual)*		●	●	●		

TABLE 1 (Continued)
ALIGNMENT OF EEIRP PRODUCTS
WITH THE SIX *P&G* PLANNING STEPS

EEIRP WORK UNIT	EEIRP PRODUCTS *(Abbreviated Title)*	1 Specify Problems & Opportunities	2 Inventory & Forecast of Conditions	3 Formulation of Plans	4 Evaluation of Effects	5 Comparison of Plans	6 Plan Selection
COST EFFECTIVENESS ANALYSIS TECHNIQUES	*Procedures Manual, Cost Effectiveness and Incremental Cost Analyses* — Interim			●		●	●
	Eco-Easy: Cost Effectiveness and Incremental Cost Analyses (Software Beta Version 2.6)			●		●	●
	Cost Effectiveness and Incremental Cost Analyses Training: **PROSPECT module* **Executive Workshop* **Practitioner's Workshop*			●		●	●
MONETARY AND OTHER VALUATION TECHNIQUES	*Review of Monetary and Nonmonetary Valuation of Environmental Investments (Valuation Review)*				●	●	●
	Linkages Between Environmental Outputs and Human Services (Linkages)		●	●	●		

TABLE 1 (Continued)
ALIGNMENT OF EEIRP PRODUCTS
WITH THE SIX *P&G* PLANNING STEPS

EEIRP WORK UNIT	EEIRP PRODUCTS *(Abbreviated Title)*	1 Specify Problems & Opportunities	2 Inventory & Forecast of Conditions	3 Formulation of Plans	4 Evaluation of Effects	5 Comparison of Plans	6 Plan Selection
MONETARY AND OTHER VALUATION TECHNIQUES (Continued)	*Environmental Valuation: The Role of Stakeholders Communication and Collaborative Planning (Stakeholders)*	●		●	●		●
	Review of Monetary Valuation Techniques — Anticipated *(Monetary Valuation)*				●		
	Procedures Manual: Valuation of Environmental Outputs — Anticipated *(Valuation Procedures Manual)*				●	●	
INCORPORATING RISK AND UNCERTAINTY INTO ENVIRONMENTAL EVALUATION	*Incorporating Risk and Uncertainty into Environmental Evaluation: An Annotated Bibliography* — Draft *(Risk and Uncertainty Bibliography)*	●					
	An Introduction to Risk and Uncertainty in the Evaluation of Environmental Investments — Draft *(Introduction to Risk and Uncertainty)*	●	●		●	●	

TABLE 1 (Continued)
ALIGNMENT OF EEIRP PRODUCTS
WITH THE SIX *P&G* PLANNING STEPS

EEIRP WORK UNIT	EEIRP PRODUCTS *(Abbreviated Title)*	1 Specify Problems & Opportunities	2 Inventory & Forecast of Conditions	3 Formulation of Plans	4 Evaluation of Effects	5 Comparison of Plans	6 Plan Selection
INCORPORATING RISK AND UNCERTAINTY INTO ENVIRONMENTAL EVALUATION (Continued)	*Procedures Manual: Approaches for Incorporating Risk and Uncertainty into Environmental Evaluation* — Anticipated *(Procedures Manual: Risk and Uncertainty)*	●	●	●	●	●	●
ENVIRONMENTAL DATABASES AND INFORMATION MANAGEMENT	*Development of the Integrated Bio-Economic Planning System* — Draft *(IBEPS Development)*					●	
	Implementation and Demonstration of the Integrated Bio-Economic Planning System — Draft *(IBEPS Implementation)*					●	●
	Integrated Bio-Economic Planning System - Version 1.0 and Manual — Draft *(IBEPS Software)*					●	●
	Building an Informational and Decision Support System for Ecological Restoration Management — Anticipated	●	●	●	●	●	●

TABLE 1 (Continued)
ALIGNMENT OF EEIRP PRODUCTS
WITH THE SIX *P&G* PLANNING STEPS

EEIRP WORK UNIT	EEIRP PRODUCTS *(Abbreviated Title)*	1 Specify Problems & Opportunities	2 Inventory & Forecast of Conditions	3 Formulation of Plans	4 Evaluation of Effects	5 Comparison of Plans	6 Plan Selection
ENVIRONMENTAL DATABASES AND INFORMATION MANAGEMENT (Continued)	*EEIRP Home Page on World Wide Web* —Anticipated	●	●	●	●	●	●
EVALUATION FRAMEWORK	*Compilation and Review of Completed Restoration and Mitigation Studies in Developing an Evaluation Framework for Environmental Resources (Case Studies)*	●		●	●	●	●
	Trade-Off Analysis for Environmental Projects: An Annotated Bibliography (Trade-Off Analysis)	●		●	●	●	●
	Incorporating Group Process Techniques Into the Planning of Environmental Projects: A General Protocol — Draft (Group Process)	●		●		●	●

III. EEIRP SUPPORT FOR RESTORATION PLANNING

In this chapter, the EEIRP's support for Corps environmental planning is explored. The discussions follow the six steps of the *P&G* as applied to environmental projects. As illustrated in Figure 3, each step is described using three elements of Corps restoration planning: (1) the conceptual foundation provided by the *P&G* and associated restoration planning challenges, (2) the direction provided by Corps ecosystem restoration guidance, (3) the planning support provided by the tools and techniques of the EEIRP products.

STEP 1: SPECIFY PROBLEMS AND OPPORTUNITIES

The first of six steps in the *P&G* planning process is Specify Problems and Opportunities. The outputs of these initial activities provide a critical foundation for subsequent planning steps. Foremost among these outputs are the problem/opportunity statement. Once this statement has been prepared, scoping activities can commence. These will develop planning objectives which address the problem and recognize planning constraints. In addition, scoping activities determine (1) significant issues to be addressed, (2) the geographic extent of the planning area, (3) alternative problems and opportunities realized due to the planned activity, (4) streamlined approaches to the current study based on examination of previous studies, (5) the tentative planning and decision-making schedule, and (6) identification of local project partners and other stakeholders.

For environmental projects, one of the important tasks in this initial planning step is to determine the significance of the site's resources. This determination is critical to both identifying problems and opportunities and to scoping the planning process. Determining the relative significance of an environmental resource can be very challenging due to the complexity of ecosystems and the lack of a standard (monetary) metric for their evaluation.

Initiation of Restoration Planning Studies

Corps ecosystem restoration projects begin when there is congressional study authorization. This may be provided under existing authorities, or it may require new congressional action. The initiation of Corps involvement is usually preceded by extensive coordination between the Corps and local interests. This coordination usually commences when local interests identify an environmental problem beyond the scope of their authority or resources. They then approach the Corps requesting assistance. Corps restoration studies can commence when the partnership between the Corps and the local sponsor has been formalized, the congressional study authorization has been obtained, and planning funds are appropriated.

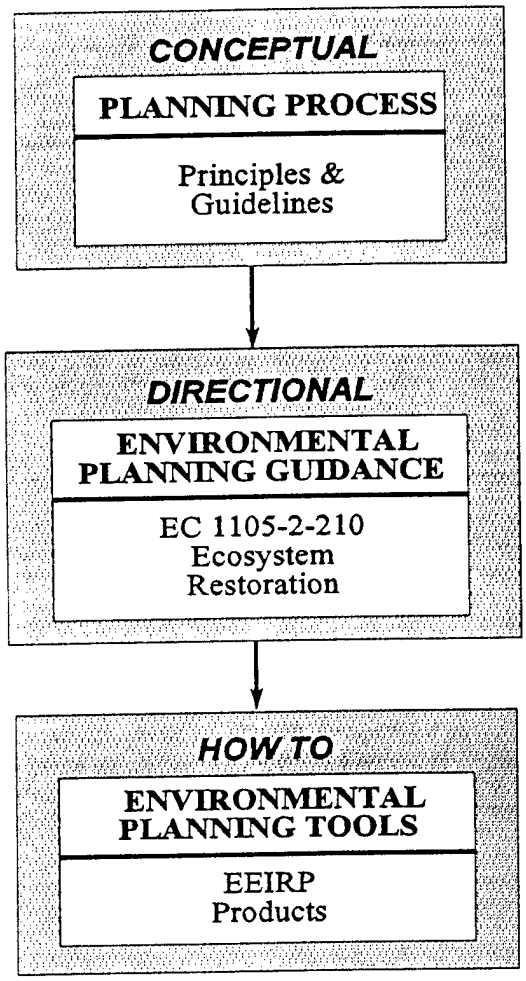

FIGURE 3
ELEMENTS OF CORPS ENVIRONMENTAL PLANNING

Corps ecosystem restoration activities concentrate on engineering solutions to water and related land resources problems. The Corps principal focus in ecosystem restoration is on those ecological resources and processes that are directly associated with, or directly dependent upon, the hydrological regime of the ecosystem and watershed(s). There may be instances where ecosystem restoration problems and opportunities would be better addressed by other agencies. Those restoration opportunities that involve modification of hydrology or substrate are likely to be most appropriate for Corps initiatives. Such activities are most likely to address ecosystems associated with wetland, riparian, and aquatic systems.

EEIRP Planning Support: Specification of Problems and Opportunities

The principal outcomes of the Specify Problems and Opportunities planning step are planning objectives and constraints. EEIRP support of the development of these products is described below.

Problem/Opportunity Statement

For environmental projects, the problems and opportunities statement typically identifies the degradation of significant environmental resources or opportunities for protection or restoration of resources that exist currently but may be lost through some other action. As outlined in the restoration guidance, EC 1105-2-210, the statement should explicitly describe Federal interest in the restoration of those resources. The problem/opportunity statement should be precise, but not so tightly focused that reasonable alternatives are prematurely eliminated. It should be accompanied by the planning objectives, which are designed to address the restoration goals. The planning objectives relate specifically to (1) significant resources, (2) anticipated changes resulting from the restoration project, (3) the target location within the study area, and (4) the time frame appropriate to accomplish the objective. The definition of environmental planning objectives should be as specific as possible. They should include, for example, target species, biological communities, or abiotic functions to be restored as well as the site or habitat characteristics to be improved. The spatial and temporal scale of the proposed restoration and performance indicators for the restoration effort should also be addressed in the definition of planning objectives.

Many EEIRP products support the development of the problem/opportunity statement and the planning scope. Those with the most direct support of problem identification include the results of applied research directed toward (1) identifying project stakeholders and including their perceptions and values in the planning process and (2) assessing the risk and uncertainty in problem identification.

Stakeholder Participation. A series of Corps restoration projects were analyzed and compared in the *Case Studies* report. This report provided a comprehensive examination of ten restoration projects. Among the findings of this report were the gains in planning efficiency and effectiveness achieved by (1) immediately identifying the project stakeholders, (2) involving them early in the planning process, and (3) encouraging their participation throughout the process. Stakeholder participation in this first planning step is critical for the Corps to foster working relationships with these interest groups. The active inclusion of project stakeholders should be considered by Corps planners as an opportunity to take advantage of local knowledge about the site and develop support for action to address the environmental problems and opportunities. The *Stakeholders* report can help to identify project stakeholders.

As identified in the *Case Studies* report, stakeholders for environmental projects typically include other Federal agencies, state natural resource agencies, nonprofit organizations, and the general public. The mix of stakeholders and their respective roles in the planning process can be quite variable. For example, active stakeholders in the Homme Lake Habitat Improvement Project, a Section 1135 restoration project, were limited to the North Dakota Department of Game and Fish, the U.S. Fish and Wildlife Service (USFWS), and Ducks Unlimited. In contrast, the Mayfield Creek Restoration Project had a much more extensive list of active project stakeholders, including:

- Kentucky Department of Fish and Wildlife
- USFWS
- Kentucky Division of Water Resources
- U.S. Environmental Protection Agency
- Kentucky Historic Preservation Officer
- Ducks Unlimited
- A land developer
- A timber company
- A real estate development company
- Private landowners

Stakeholders may be involved with any of the six planning steps. However, the participation of different stakeholders may be more appropriate in some planning activities than in others. The participation of a broad range of stakeholders may be desirable in this first planning step, since their awareness of local conditions or concern for specific project features can greatly inform the Corps planning process.

The input of stakeholders to the planning process will largely depend on their perceptions of the values of the site with and without restoration. The ways in which stakeholder values are formed and expressed are explored in the *Stakeholders* report. Environmental planners must recognize that although the project stakeholders may unanimously support restoration, they may have very different perceptions of project planning, design, tools to be used, and schedule for budget allocation and project completion.

As the *Trade-Off Analysis* report illustrates, small group processes can be very useful in (1) eliciting the values of stakeholders and (2) generating information about the site and the problems and opportunities. Very few water resources or environmental decisions are currently made by one individual or organization. There are simply too many parties and interests involved with these resources. The Corps recognizes this reality and endeavors to improve its cooperation with local project partners and to solicit the general public's input to the planning process. For environmental projects, an even greater level of coordination with stakeholders may be required for effective and efficient project planning.

The *Trade-Off Analysis* report also explores the ways in which the informational, analytical, or decision-making needs of project planning can be supported by small group processes. In this report, alternative group processes are profiled, and their appropriateness for different planning contexts is characterized. In this report, small group techniques are organized into two primary

categories: (1) those that generate (or clarify) ideas and (2) those that evaluate alternatives. To help develop the statement of problems and opportunities and establish a collaborative planning process, the initial meeting of the project stakeholders should focus on idea generation and be designed accordingly.

The selection of a process that is appropriate for particular circumstances must consider all of the variables surrounding the planning effort. Although group process techniques appear relatively simple, their successful application to different groups and subjects can require very high levels of expertise. The *Group Process* report identifies alternative small group techniques and lists criteria for selecting an appropriate technique. This report provides descriptions of the process and products of each technique.

Uncertainty in Developing the Problem/Opportunity Statement. There is uncertainty surrounding virtually all aspects of the planning process. However, the development of the problem/opportunity statement is an especially critical task, and the uncertainty surrounding it is therefore of particular concern. The purpose of the planning process is to develop and evaluate restoration alternatives for specific site resources. However, there may be significant uncertainty about the identity or nature of the problem. In addition, the links between the problem, resource degradation, and the planning objectives may not be well supported. As a result, there could be substantial uncertainty between the restoration action and ecosystem reaction. The potential uncertainty can be limited by a carefully developed problem statement that includes cause-and-effect linkages as well as scientific support for those linkages. Another common source of uncertainty at this step is that problem statements may be either too vague or too specific (i.e., so vague that measuring the projects success is problematic, or so specific that solutions are preordained as an objective).

The process of developing a clearly defined and specified problem/opportunity statement has been one of the focuses of the EEIRP. In *Introduction to Risk and Uncertainty*, sources of uncertainty surrounding the problem identification step, as well as approaches to address them, are discussed in a general sense. In the forthcoming *Procedures Manual: Risk and Uncertainty*, the details of more specific techniques will be further developed. Both of these reports build upon the *Risk and Uncertainty Bibliography*, prepared during an early phases of the EEIRP.

Planning Scope

The planning scope includes issues to be addressed, the definition of the study area, and project milestones. For ecological, cultural, aesthetic resources to be included in project planning, the *P&G* stipulates that they must be "significant." For restoration projects, determination of the significance of the site's resources is critical and challenging. Resource significance may be assessed on the basis of institutional, public, or technical significance. In this first step of the planning process, the outputs of the assessment of resource significance are oriented toward institutional significance. This information is immediately available and does not need to be

developed through ecosystem analysis or public involvement activities, as is the case for technical and public significance, respectively. Alternative programs and models to assess significance are described below. These would be supplemented by the results of group processes used to elicit stakeholder values.

Resource Significance. The *P&G* requires evaluation of a project's effects (beneficial or adverse) on the ecological, cultural, and aesthetic attributes of significant natural and cultural resources. The recognition and documentation of the significant resources in a project study will ultimately be what defines Federal interest in a project. The *P&G* stipulates that significant environmental quality (EQ) resources and attributes that are institutionally, publicly, or technically recognized as important be taken into account in decision making. Focusing on significant issues is also required by Council on Environmental Quality regulations, and makes practical sense; narrowing a large list of resources to only those that are significant allows for a more efficient and meaningful study. While the *P&G* elaborates further on what comprises institutional, technical, or public significance, there is a need for further guidance and procedures to operationalize these factors into the planning process. Procedures are required that will assist in the identification and display of determinations of significance.

A survey of significance programs and models was assembled in *Significance: New Perspectives*. This report was designed to assist planners in identifying the type of information needed to determine resource significance. It was also designed to highlight the importance of resource significance in the planner's eye. Ninety-five Federal, regional, state, and nonpublic organizational programs were identified which address the issue of resource significance and prioritization. These significance programs are organized by parameters such as geographic scale, political scale, ecosystem type, and program type. The scale parameters include international, national, regional, state, and local areas. The ecosystem types encompass wetlands, rivers, riparian areas, lakes, estuaries, watersheds, fish and wildlife habitat, and threatened and endangered (T&E) species.

Significance Protocols. The forthcoming *Significance: Resource Document* will provide additional background information on significance and will constitute an easy reference to laws and regulations pertaining to institutional, technical, and public significance. It is designed to be a guide for determining significance and communicating that information to decisionmakers. In addition, significance protocols are being developed to help planners and local partners identify those resources that are significant institutionally, technically, and/or publicly at the national, regional, state, and local levels. The significance protocols are being designed as a user-friendly guide for identifying and prioritizing significant resources. The protocols will be field-tested prior to final publication in the *Significance: Protocols* report.

Cultural Resource Significance. Although restoration planning may focus on natural resources, cultural resources are also an important planning parameter. Cultural resources have conventionally been thought of in terms of Section 106 (National Historic Preservation Act)

compliance rather than the comprehensive management and stewardship requirements of Section 110. The concept of significance has been continually redefined and expanded beyond contemporary archeological research to consideration of broader public and social values as explained in the Briuer and Mathers paper in *Cultural Resource Significance: New Directions.* In considering significance of cultural resources in a broader context, the literature provides a number of concepts useful in developing information on significance. In *Cultural Resource Significance: Trends and Patterns,* this literature is synthesized in an interpretive analysis of the following significance concepts:

- Definitional/evaluation criteria
- Representativeness and redundancy
- Cultural resource management research designs
- Proactive management strategies
- Public involvement
- Use and development of new analytical approaches
- Field procedures
- Federal legislation

Results of This Step

The problem identification activities pursued in this initial planning step generate the problem/opportunity statement, planning objectives, and planning scope. These outputs of this planning step will serve as important foundations for the second planning step, Inventory and Forecast of Conditions.

STEP 2: INVENTORY AND FORECAST OF CONDITIONS

The second step of the six-step planning process is to inventory current resources and forecast future conditions at the site without implementing a project. These activities develop a baseline of current conditions and then forecast the without-project conditions through the period of analysis. For environmental projects, it is especially important to discuss the significant resources in the with- and without-project conditions.

In this second planning step, restoration planning typically focuses on (1) identifying key determinants of the ecosystem structure and function and (2) adapting or developing a model of the ecosystem. The model development is contingent upon the problems/opportunities specified in the first planning step. Once the ecosystem model is developed, it can be applied to forecast the without-project future condition.

Development of the Without-Restoration Future

The restoration guidance EC 1105-2-210 describes the inventory of conditions for environmental projects. This inventory determines the quality and quantity of resources, significant and otherwise, delineated during scoping activities and identifies opportunities for ecosystem restoration. It should be limited to those resources that are key to the structure or function of the ecosystem. The outputs of the activities for anticipating the without-project future include (1) an understanding of the structure and function of the ecosystem, (2) a conceptual model for that ecosystem, and (3) a quantitative ecological model of the ecosystem structure and function. The without-project condition can then be developed using the model with the quantity, quality, and mix of ecosystem inputs that are expected if no action is taken.

EEIRP Support: Inventory and Forecast of Conditions

The development of the without-project future and the ways in which this is supported by products of the EEIRP are described below. As part of the development of the without-project condition, there are also (1) important risk and uncertainty issues and (2) opportunities to include project stakeholders in this planning step, perhaps in the identification or collection of data. These issues and opportunities will be discussed as well.

Ecosystem Structure and Function

Developing the without-project future for a site requires understanding the structure and function of the ecosystem. The appropriate level of detail will depend on the planning circumstances, the complexity of the ecosystem, and the restoration objectives. Profiles of different ecosystems and habitats are compiled in *Restoration Parameters.* This report provides a description of ecological concepts that should be considered for restoration projects. Habitat profiles for aquatic, coastal, estuarine, wetland, riverine, and lacustrine ecosystems are presented using the following parameters:

- Physical condition
- Conceptual models
- Geographic distribution
- Zonation within habitats
- Biological community
- Key ecological processes

The forthcoming *Engineering Procedures Manual* will also be helpful in addressing both ecosystem structure and function. In particular, this report will contain: (1) a general process for

ecosystem evaluation, (2) discussions of the relations between structure and function, and (3) specific techniques to determine structure and function of a given ecosystem.

In the first planning step, Specify Problems and Objectives, the outputs of the assessment of resource significance were oriented toward institutional significance. In this second planning step, the technical and public significance is given more prominence in the assessment of resource significance. Technical significance is addressed via the ecosystem profile. Public significance is included in the habitat description, particularly the suitability for a species of public concern or interest. The EEIRP reports *Significance: New Perspectives*, *Significance: Resource Document*, and *Significance: Protocols* are all relevant here.

Conceptual Ecosystem Model

As the structure and function of the site ecosystem is investigated, a conceptual model of the ecosystem can be developed. As indicated in *Restoration Analysis*, conceptual ecosystem models typically illustrate relationships between target species, restoration performance indicators, and key ecological parameters. Conceptual ecosystem models generally include:

- Key abiotic processes or habitat characteristics
- Food web structure and key resource species
- Foundation, keystone, and engineer species
- Optimal physical characteristics of restoration
- Successional sequences after disturbance
- Spatial and temporal homogeneity
- Natural disturbance regime
- Landscape influences

Quantitative Ecosystem Model

Once the conceptual model of the ecosystem has been developed, the conceptual relationships can be quantified to the extent possible in order to (1) simulate the dynamics of chemical, material, and energy flows in the ecosystem and (2) estimate how inputs to the system, such as a certain quantity or quality of water, translate into the ecosystem outputs of concern (e.g., acres of habitat for a given T&E species). Quantitative does not imply comprehensive. For some ecosystems and planning objectives, a relatively simple model can effectively represent the structure and function of the ecosystem.

In *Restoration Analysis*, more than 750 annotated and indexed citations relevant to ecological modeling are provided. The ecological models reviewed are differentiated by their treatment of ecosystem functions and geographic scales. Among the different types of models reviewed are

habitat models, species population models, energy or material flow models, and models based upon individual species. Most models currently in use for planning purposes are habitat models.

The technical appropriateness and availability of planning resources guide the selection of an ecological model. Among the technical criteria are (1) the objectives for which the model is intended to support, (2) those site resources that are significant, and (3) the emphasis on variables that are subject to management manipulation. These technical criteria reinforce the importance of a clear direction for the planning effort that comes from the first planning step. In *Restoration Analysis*, the technical appropriateness of alternative models is assessed for different planning contexts.

Data collection and management are critical activities in the development of the without-project future. The data needs of the ecosystem model are paramount. The ecosystem model cannot be used effectively if the required data are unavailable, inaccurate, or inconsistent. In *Restoration Analysis*, the variables that Corps restoration projects might affect are identified. The role of models in planning should not be emphasized to the exclusion of other sources of information about alternative future conditions. Information that is nonquantitative or not required by the model can still be relevant to the without-project condition and, ultimately, decision making.

Without-Project Conditions

The report *Restoration Parameters* also describes the process to develop the without-project conditions. Since ecosystem models cannot include all possible factors that determine ecosystem structure and function, the most important parameters must be identified. This can occur through specific research into the ecosystem structure and function or via the process of ecosystem modeling. There may be a single, readily identifiable key parameter such as a particular hydrologic regime or levels of a specific nutrient. The key parameters could also be a very subtle combination of ecological factors. After the quantitative ecological model has been developed, the critical parameters can be forecasted and input to the model to assess ecological conditions in the absence of restoration action. This assessment is combined with information that is nonquantitative or outside of the model to forecast the without-project future.

The *Linkages* report can be used to develop a baseline of human services/goods that the site would provide without restoration action. The without-project ecosystem outputs can be input to the linkages tables to forecast human services/goods through the planning period. Software versions of the linkages tables are currently being prepared. These will allow easier use of the linkage material, as well as provide automated report generation.

Uncertainty in Forecasting: Without-Project Conditions

The forecasting of the without-project future is a fundamental exercise in uncertainty. However, uncertainty can be unnecessarily exacerbated when specific forecasts are made without acknowledging the inherent uncertainty. Another problem can be created when data collection efforts focus on the quantity, not the relevance, of information. Conversely, there can also be problems associated with too little information. This might be reflected in excessive reliance on professional judgements or extrapolations from existing information. In general, the accuracy of subjective data and professional judgements can be improved by assigning an interval estimate rather than a point estimate to future conditions (e.g., an uncertain quantity is described as between two values rather than stated as a point value). Sensitivity analysis can also be used to calibrate extrapolations, for example, either by varying outcomes — by plus or minus some percentage — to identify ranges of future without-project conditions or by systematically varying critical variables.

In *Introduction to Risk and Uncertainty*, the issues surrounding uncertainties in baseline and future without-project conditions are described, and alternative methods of addressing these uncertainties are identified. The forthcoming *Procedures Manual: Risk and Uncertainty* presents different risk-based methods of forecasting future without-project conditions in greater detail.

Coordination with Stakeholders: Information Sources

Project stakeholders can support the Inventory and Forecast of Conditions activities. They may be very aware of the ecosystem structure and function. Stakeholders can also help identify sources of data that can serve as inputs to the ecosystem model or otherwise support the planning process. Critical sources of information for this step may be state natural resource agencies.

A separate group meeting might not be required for this planning step. Instead, a problem identification meeting in the first step, if properly designed and executed, could provide feedback regarding ecosystem structure and function and identify sources of ecological data.

Significant Cultural Resources

The forecasting of future conditions of significant cultural resources is dependent on availability of data and resources to analyze and project future conditions. *Cultural Resource Significance: Regional Models* demonstrates the use of GIS and development of a regional model to anticipate future impacts on these resources. Although the ability to expend this level of effort is not always possible or appropriate, GIS is becoming increasingly accessible and provides the capability to evaluate large regions and complex inventories of sites.

Results of This Step

There are four principal outputs of this second planning step. The first three outputs are (1) an understanding of the ecosystem structure and function, (2) a conceptual model of the ecosystem that identifies key resources and processes, (3) a quantitative ecological model. The model when combined with forecasts of key ecological parameters generates the fourth output, the without-project conditions. As discussed with the following step, Formulation of Plans, alternative plans can also be formulated using information from the ecosystem model.

STEP 3: FORMULATION OF PLANS

The third step of the six-step *P&G* planning process is Formulation of Plans. In this step, the planning objectives and resource conditions developed in the two previous steps are used to convert remedial strategies into alternative plans. It is an iterative process that identifies structural and/or nonstructural measures that (alone or in combination) can accomplish the planning objectives. The formulation process seeks to develop alternative plans that are complete, effective, efficient, and acceptable. The alternatives are often differentiated by location, scale, materials, and timing.

Although environmental projects are ecosystem-based, the plan formulation process can involve considerable engineering analysis and design. The plans may entail modification of the operation or structure of existing Corps projects or the construction of new facilities. Alternative plans should be formulated to respond to the objectives. These plans must be sufficiently developed to allow an informed review of their effects in the next planning step.

Coordination with project stakeholders is a critical activity in this step. The stakeholders can provide important insight into the design of alternative plans. They may have ideas, information, data, or technical expertise that must be considered in the plan formulation process. For some restoration projects, local stakeholders may have already considered and developed alternative plans. In addition, stakeholder acceptance of the planning process and, ultimately, the recommended plan is critical to efficient implementation of the project.

Restoration Plan Formulation

The same quantitative ecological model developed to forecast the without-project future in the second planning step can be used to forecast alternative with-project futures. In general, the formulation of alternative restoration plans begins with the planning objectives established in Step 1 of the planning process, Specify Problems and Opportunities. The objectives of restoration projects are typically combinations of (restored) ecosystem outputs. While there may be some preconceived concept of what outputs will meet the restoration objectives, a range of ecosystem outputs is usually considered in restoration planning to ensure that the most desirable restoration

level is selected. Using the quantitative ecological model developed in Step 2, alternative quantities, qualities, and combinations of ecosystem inputs that could achieve the alternative output levels can be identified. The alternative inputs will be based on key ecological parameters identified in Step 2. Engineering feasibility studies can then specify alternative engineering and/or other measures that can establish and maintain the ecosystem inputs to produce the desired restoration effects. Therefore, through the engineering analysis, the costs of alternative plans are determined. Multiple iterations through this sequence of activities will result in the formulation of alternative restoration plans.

The challenge of formulation activities for restoration projects is that there is often no clear NED plan, since most or all of the benefits are nonmonetary. In response to this nonmonetary orientation, EC 1105-2-210 specifies that nonmonetary outputs should be used as the measure of restoration projects:

> "Therefore, consistent with the analytical framework established by the *P&G*, plans to address ecosystem restoration should be formulated, and measures for restoring ecological resources may be recommended, based on their monetary and nonmonetary benefits. These measures do not need to exhibit net NED monetary benefits and should be viewed on the basis of nonmonetary outputs compatible with the *P&G* selection criteria and be offered for consideration and budget support."

EEIRP Planning Support: Restoration Plan Formulation

The EEIRP supports restoration plan formulation. The determination of appropriate combinations of ecosystem inputs and the development of effective environmental engineering measures are two areas of EEIRP support. The EEIRP also helps planners recognize and reduce the considerable uncertainty associated with the formulation of restoration plans. As discussed in *Introduction to Risk and Uncertainty*, planners can reduce the uncertainty in plan formulation by reducing the uncertainty associated with their planning objectives and by providing as broad a range of alternatives as possible. In the forthcoming *Procedures Manual: Risk and Uncertainty*, detailed approaches for reducing risk and uncertainty in the formulation of alternative plans will be presented. The different ways in which the EEIRP supports restoration plan formulation are described below.

Combinations of Ecosystem Inputs

The development of the quantitative ecosystem model used to forecast the with- and without-project conditions has been previously outlined. As described in those discussions, the EEIRP supports model development activities with the reports *Restoration Analysis* and *Restoration Parameters.*

The details of determining key ecological parameters and ecosystem inputs and outputs are discussed in *Restoration Parameters*. As outlined in that document, for any given restoration project, there may be different combinations of ecosystem inputs that could achieve the restoration objectives. It may be that a single critical ecosystem input is required in greater quantity or quality, or it may be necessary to modify multiple ecosystem parameters. The alternative input combinations that produce the desired results may be differentiated on the basis of the quantities, qualities, or mix of inputs. The inputs may be water regimes of certain quality or quantity, critical nutrients, or material/energy flows. Using sensitivity analyses in the quantitative ecosystem model can assess how the ecosystem might respond to different combinations of inputs. During plan formulation, a range of outputs are typically considered to identify the optimal restoration level. Those combinations of inputs that are found to be feasible from an ecological perspective are carried forward to the environmental engineering analysis.

Restoration Engineering

The role of environmental engineering in restoration projects is to produce or deliver the ecosystem inputs that could meet the restoration goals. Engineering feasibility studies seek to identify those measures that can produce the alternative combinations of ecosystem inputs under consideration. The EEIRP has been supporting engineering feasibility analyses for restoration projects with a variety of technical reports that will culminate in an engineering procedures manual for these projects. The EEIRP's support of environmental engineering is outlined below.

One of the first tasks of the environmental engineering effort of the EEIRP was to conduct a review of Corps and non-Corps environmental restoration programs. The report *Non-Corps Restoration* profiles the restoration experience of other Federal and non-Federal agencies. This profile focuses on the engineering measures utilized to meet the site-specific restoration objectives and the lessons learned from field trials of restoration techniques.

The EEIRP's environmental engineering research is drawing upon Corps and non-Corps restoration experience in its development of new restoration techniques. In the *Corps Restoration* and *Non-Corps Restoration* reports, as well as in *Monitoring Guidance*, this experience is compiled and evaluated. Given the diversity of perspectives on restoration tools and experience and the large number of alternative environmental engineering measures, the management of engineering information assumes a very important role in the Formulation of Alternatives planning step. The *Information Tree* report has begun the process of organizing restoration experience for application to new restoration projects. The report *Restoration Parameters* provides additional information on environmental restoration projects of the Corps and other agencies using a series of case studies.

As explored in *Restoration Parameters*, restoration project failures can be as valuable as successes, and descriptions of project experience in this evolving science must include setbacks as well as advances. In that document, descriptions of alternative restoration measures are presented, including objectives met. In addition, the EEIRP is enhancing the translation of restoration experience into prescriptions for restoration action by preparing *Monitoring Guidance*. The success

of restoration engineering measures can be only judged through long-term monitoring of restoration projects. Few engineering measures for restoration projects are established practices, and the responses of complex ecosystems to restoration measures are often uncertain.

The capstone product of the EEIRP's environmental engineering research is the *Engineering Procedures Manual*. This document summarizes the role of engineering within the *P&G* process and provides guidance for engineering analyses. The document identifies linkages between ecosystem structure, function, objectives, management approaches, and specific engineering techniques and features. Monitoring, maintenance, and cost information are also provided.

In the *Linkages* report, the connections between environmental outputs and human services are traced. The linkage tables contained in this report could be used to identify restoration activities that would achieve desired project outputs with direct inference to specific engineering measures.

Restoration Alternatives

There are three primary approaches to environmental plan formulation: (1) draw upon plans of others, (2) seek the advice of experts, and (3) assemble all possible combinations of management measures. The first approach utilizes the plans of others as a foundation for plan formulation. This might include plans developed by local project partners, other stakeholders, state agencies, or other Federal agencies. The second approach taps the professional judgement and informed personal intuition of "experts" in appropriate disciplines. This process of consulting experts in the development of alternative plans has been common in Corps water resources planning. Examples of technical experts may include in-house Corps personnel, consultants (e.g., firms and academics), or experts in other agencies (Federal, state, or local), and interest groups. The third approach, which assembles all combinations of management measures, begins with a list of individual measures and formulates plans by deriving every possible combination of those measures. The resulting set of combinations is the entire set of alternative plans that can be generated from the measures under consideration. The individual measures might be identified by either of the two previously described approaches to plan formulation.

In the report *Case Studies*, the importance of stakeholder input to the formulation of alternative plans is a recurrent theme. The value of the experience of stakeholders with the project cannot be understated. As described above, some stakeholders have already developed detailed restoration plans before they approach the Corps for assistance. These can serve as a foundation for Corps project planning. The potential contributions of stakeholders to the plan formulation process are described in more detail in the *Stakeholders* report. This latter document reiterates the political reality that stakeholder support of alternative plans is an important measure of their political and institutional feasibility.

As explored in the *Trade-Off Analysis* report, group processes can be used to generate ideas or to make decisions. The formulation of alternative plans is perhaps the best example of utilizing

stakeholders potential to generate ideas about alternative means to achieve the restoration objectives. The *Group Process* report identifies multiple meeting designs that can be used for this purpose.

The procedures for cost effectiveness and incremental cost analyses are presented in: *(1) Interim Procedures Manual, Cost Effectiveness and Incremental Cost Analyses, (2) Eco-Easy Software*, and (3) *Cost Effectiveness and Incremental Cost Analyses Training* (PROSPECT module, Executive Workshop, and Practitioner's Workshop). These procedures are supplemented with a plan formulation process that formulates the possible combinations of a given set of solutions (management measures or alternative plans). The formulation procedure precedes the cost analyses and begins with a list of solutions and estimates of the environmental output and dollar cost of each solution (and each scale or size of a solution, as applicable). The procedure then elicits information about the combinability and dependencies among the solutions. Finally, the procedure develops every combination of the solutions, screening out combinations that do not meet the defined combinability and dependency conditions.

The *Linkages* report can be used to forecast human services/goods that the alternative restoration plans would produce. The with-project ecosystem outputs can be input to the linkages tables to forecast human services/goods associated with alternative plans.

Results of This Step

For restoration projects, the third planning step, Formulation of Plans, identifies alternative means to achieve the restoration goals. These plans result in alternative with-project futures. Once an appropriate range of alternative plans has been formulated, they can be carried forward to the next planning step, Evaluation of Effects.

STEP 4: EVALUATION OF EFFECTS

The fourth step in the six-step planning process of the *P&G* is Evaluation of Effects. The objective of this step is to identify, measure, and weigh how project resources are likely to be affected by alternative restoration plans. Alternative plans formulated in the preceding step should be complete, effective, efficient, and feasible. The feasibility of each alternative is evaluated from the institutional, political, social, technical, financial, economic, and environmental perspectives. The plans must be significantly distinguished to provide decisionmakers an appropriate range of alternatives to consider. In this step, these criteria are used to begin the process of screening alternatives that eventually results in a recommended plan.

The Evaluation of Effects planning step includes two primary activities: assessment and appraisal. Assessment activities objectively identify (1) the differences between the with- and without-project futures, (2) the effectiveness of meeting objectives, and (3) other project effects.

Appraisal is a more subjective process of weighing the effects identified by assigning their social values.

For restoration planning, both assessment and appraisal of effects are problematic. The challenges for this planning step include the difficulties of assessing and forecasting project effects and comparing those effects with those of the without-project future. There are many difficulties in determining how the ecosystem will respond to different inputs, including those consistent with the without-project future. There are questions of not only whether the plans under consideration will achieve the restoration objectives but also what other effects, ecological and otherwise, those plans might have.

Restoration Effects

For traditional water resources development projects, the evaluation of effects includes assessment and appraisal of the costs, benefits, and other effects of alternative plans. For restoration projects, the costs can be evaluated in this planning step by combining the results of the engineering analyses from the preceding step with economic analyses of the construction and operation and maintenance costs. Estimating the benefits and other effects of restoration plans can be much more difficult.

Evaluating the ecological effects of restoration projects is probably the most critical challenge of environmental planning. One component of this problem is that the differences in ecosystem outputs between the with- and without-project conditions are very difficult to estimate with accuracy. This places ecosystem models in a planning role that they have difficulty in fulfilling, given the current refinement of these models and the complexity of ecosystems. Nevertheless, as described in the discussion of Step 2, there are available methodologies and models, such as HEP, that can be used to assess the ecosystem effects of restoration alternatives. Both the with- and without-project scenarios have substantial uncertainty in their forecasts. It can be very challenging to quantify the differences between the scenarios and isolate the effects of alternative plans.

A second component of this problem is the difficulty in appraising ecosystem effects (i.e., translating ecosystem outputs into monetary units). Ecosystem outputs clearly are valued by society. However, the monetary valuation of those values is very difficult. An ecosystem can provide socially-valued services, but the willingness of society to pay for these services, often public goods, is unclear. The result is that even if the changes in ecosystem outputs can be determined, the estimation of the benefits in monetary terms may for practical purposes be impossible at this time.

EEIRP Planning Support: Evaluation of Restoration Effects

The practical response of the Corps to the difficulty of evaluating effects of restoration alternatives has been to accept that project benefits are often impossible to fully monetize and to promote the use of cost effectiveness and incremental cost analyses. As described below, the focus of the EEIRP's research regarding this planning step includes these analyses, the monetary evaluation of restoration benefits, and the comparison of the with- and without-project conditions.

Evaluation of Restoration Benefits

The EEIRP has endeavored to better explain linkages between environmental outputs and socially valued services so that available tools to measure restoration benefits in monetary terms can be used effectively. The first EEIRP product associated with this effort was the *Valuation Review* report. This document provides an overview of the valuation dilemma raised by the loss of the NED decision rule. It presents a detailed discussion of the challenges associated with monetizing environmental resources from the disciplinary perspectives of economics, engineering, social psychology, and ecology. It includes a compilation of monetary and nonmonetary valuation techniques in other Federal agencies and an analysis of the Corps institutional setting for adoption of existing methodologies. The concepts and reality of valuation are further described in the *Stakeholders* report, with actual projects used to illustrate selected points.

One of the weaknesses of existing techniques to place monetary values on environmental resources lies in the complex connections between environmental outputs and socially valued services. In the *Linkages* report, these connections are strengthened with ecosystem-specific matrices that align ecosystem outputs and socially valued services. As described in Steps 2 and 3, the linkage tables in this report can be used to identify services associated with the with- and without-project futures, respectively. In this fourth planning step, these services can be compared to anticipate incremental increases in human services (i.e., benefits) associated with alternative plans. The forthcoming *Monetary Valuation* report will be a manual to link those outputs that can be associated with measurable (monetary) human service benefits with existing tools.

The *Valuation Procedures Manual* will discuss alternative methods of collecting value information tied to ecological outputs resulting from each alternative considered. This report will examine the importance of human values to environmental decision making and provide support in determining these values. First, the use of the *Linkages* report to determine the human goods and services which result from a project is discussed. Second, the use of monetary and nonmonetary valuation techniques to elicit value information about these human goods and services is presented.

Trade-Off Analyses

The *Trade-Off Analysis* report summarizes techniques for use in evaluation of alternatives. Multiobjective Analysis (MOA) techniques describe the impact of project alternatives on objectives of the project and show how alternatives differ with respect to different resources and benefits affected by a project. Additionally, some of the summaries in the *Case Studies* report encountered difficulty in evaluation and prioritization of projects or alternatives when there was a mix of subjective and quantitative information. MOA techniques can be used to incorporate both types of information in an evaluation.

Uncertainty in Evaluation of Restoration Effects

Evaluations of effects associated with alternative restoration plans have uncertainty that derives from the inability to forecast plan effects with perfect foresight. How well will the project perform? How good are our estimates of project outputs? In *Introduction to Risk and Uncertainty*, a simple example is presented illustrating how risk-based analysis can be used to address some of the uncertainty inherent in the estimation of habitat outputs for alternative plans. In the *Procedures Manual: Risk and Uncertainty*, a more thorough discussion of the advantages and disadvantages of various risk-based methods to estimate with- and without-project outputs is presented.

Cultural Resource Impacts

The evaluation of effects for significant cultural resources is determined by identifying the impacts resulting from the alternative plans. Use of GIS and predictive models can assist in describing the extent of effects on cultural resources. Development of a regional model as described in *Cultural Resource Significance: Regional Models* will allow quantitative assessment of these impacts.

Results of This Step

The Evaluation of Effects planning activities produce assessments of the differences between the with- and without-project conditions for restoration projects. The anticipated effects of alternative plans are then carried forward to the comparison process in the next step.

STEP 5: COMPARISON OF PLANS

In the fifth planning step, Comparison of Plans, the differences between alternative plans are examined and weighed. These activities are based on the positive and negative effects identified in the preceding step. Both quantitative and qualitative plan comparisons are frequently necessary. The points of reference for the comparisons are the planning objectives established in the initial planning step. The comparisons of alternatives must be explicit and objective. The underlying goal of the comparison of plans is to provide information for the plan selection process in Step 6.

Again, environmental projects challenge traditional planning methodologies. These challenges derive from the predominance of nonmonetary benefits that characterize many restoration projects and the high level of dependence of restoration projects on new or evolving ecosystem models. In many cases, cost effectiveness evaluation methodologies are the most appropriate means of comparing alternative restoration plans.

Comparison of Restoration Alternatives

Figure 4 shows some of the tools of economic analysis that can be used to provide varying levels of information to support decision making. This decision support continuum ranges from cost-oblivious decision making (ignore all information about costs) to benefit-cost analysis (a mathematical comparison of benefits and costs). Between these two extremes, the economic tools of cost effectiveness and incremental cost analyses can provide information to support decision making.

Benefit-cost analysis is generally considered the "best-case scenario" for Federal water resources plan evaluation. In benefit-cost analysis, the monetary cost of a plan is subtracted from the monetary value of the benefits to be provided by that plan to compute net benefits. When there is a range of alternative plans, the plan that provides the most net benefits is typically the recommended plan. When project benefits are not measured in dollars, cost effectiveness and incremental cost analyses offer "next-best" approaches for plan evaluation. While the cost effectiveness and incremental cost analyses of alternative plans may not identify a unique or "optimal" solution, they can lead to better-informed choices from among alternatives by elevating the decision making process above cost-oblivious decision making. The tools of cost effectiveness and incremental cost analyses weigh the costs of restoration and mitigation plans with the nonmonetary measures of output. Such evaluation is at the heart of the analyses and is the basis for their application in environmental planning.

The restoration guidance EC 1105-2-210 recognizes that many restoration projects are characterized by a predominance of nonmonetary benefits. It exempts restoration planning from the net NED benefits and should be viewed on the basis of nonmonetary outputs compatible with the

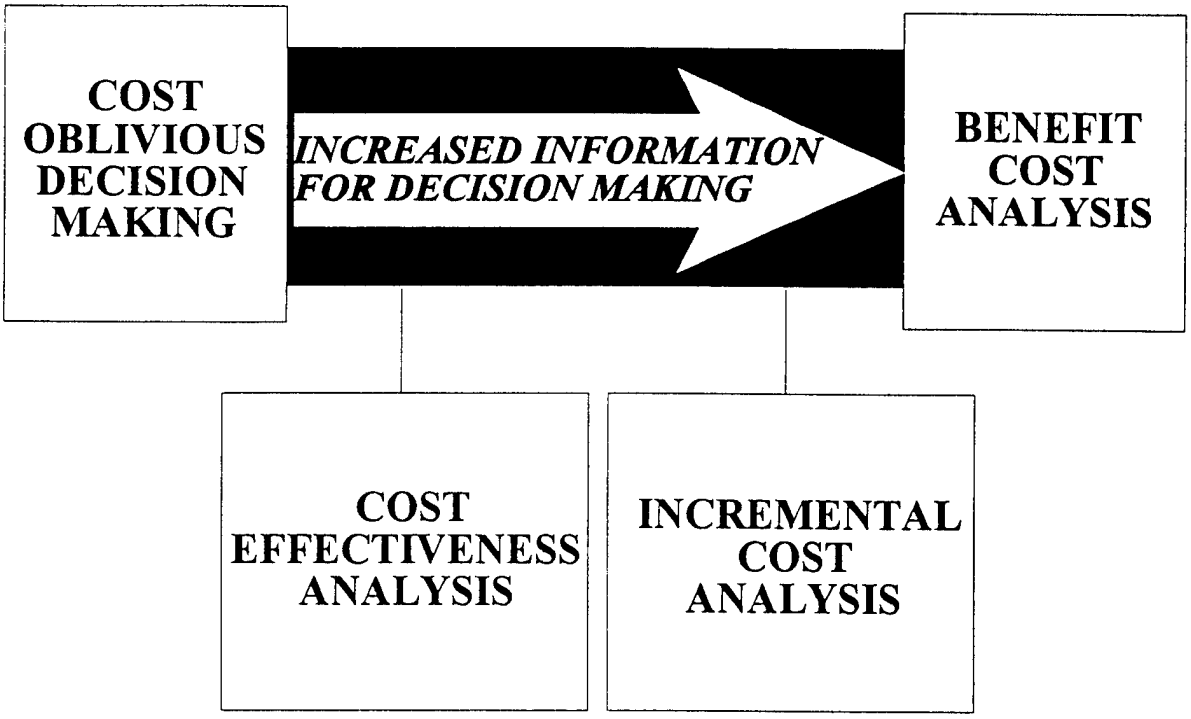

FIGURE 4
DECISION-SUPPORT CONTINUUM

P&G selection criteria, and be offered for consideration and budget support." In the absence of monetary measures of restoration benefits, the comparison of alternative plans can be most effectively accomplished using cost effectiveness analysis.

EEIRP Planning Support: Restoration Plan Comparison

The EEIRP has endeavored to develop standardized methodologies for the comparison of alternative restoration plans. The principal avenues through which the EEIRP supports the comparison of plans are the development of an incremental cost curve and trade-off analysis.

Cost Effectiveness Analysis

As highlighted in the Chapter II, environmental projects differ from traditional water resources development projects in that their benefits often cannot be measured in monetary terms. This has given impetus to the development of environmental decision-making techniques that can evaluate and compare the efficiency and effectiveness of alternative restoration plans without a traditional benefit-cost analysis.

EC 1105-2-210 requires that restoration proposals include cost effectiveness and incremental cost analyses. Cost effectiveness analysis is conducted to ensure that the least-cost alternative is identified for various levels of ecosystem output. The subsequent incremental cost analysis is intended to evaluate changes in costs for increasing levels of ecosystem output. Cost effectiveness and incremental cost analyses are associated with Steps 3, 5, and 6 of the planning process. These analyses are described in the *Procedures Manual: Cost Effectiveness and Incremental Cost Analyses* and the *Eco-Easy Software*.

Cost effectiveness and incremental cost analyses are means to compare the environmental outputs and economic costs of alternative plans. In planning for environmental restoration and mitigation, classic benefit-cost analysis is often difficult, if not impossible, because, although costs of environmental projects can still be measured in dollars, there is no universally accepted method to express environmental benefits in a single metric — dollars or otherwise. Therefore, while it is not possible to use traditional benefit-cost analysis for environmental planning, other tools, such as cost effectiveness and incremental cost analyses, can be used. Many of these ideas are also discussed in the *Valuation Review* report.

Cost effectiveness analysis is designed to identify the least cost solution for each possible level of environmental benefits. Subsequent incremental analysis reveals changes in cost for increasing levels of benefits. Together, these analyses provide a more informed basis for judging the value of potential restoration and mitigation projects. The step-by-step procedure for conducting these analyses is described in the *Procedures Manual: Cost Effectiveness and Incremental Cost Analyses* and can be conducted by pencil and paper or, in more complicated situations, by using the *Eco-Easy Software*.

Significant costs associated with restoration projects can include land acquisition, materials, construction, monitoring, and maintenance. The *Engineering Procedures Manual* presents summary information on the costs associated with materials, construction, and maintenance for a number of restoration strategies. Costs associated with monitoring efforts are presented in the *Monitoring Guidance* report. The *Engineering Procedures Manual* also discusses the potential effectiveness of various restoration techniques.

As cost effectiveness and incremental cost analyses determine the additional cost of each successive level of ecological output, the *Valuation Procedures Manual* will help the planner determine the additional benefit of each successive level of ecological output. In Step four, value information, both monetary and nonmonetary, was collected for ecological outputs resulting from each alternative considered. In this planning step, Comparison of Alternatives, this value information is presented to decisionmakers to help them determine if each additional unit of output is worth the additional cost determined within the cost effectiveness and incremental cost analyses. To support this process, the *Valuation Procedures Manual* will discuss the use of monetary valuation as a means to elicit value information as well as reduce the number of output measures which need to be considered. Also, this manual will provide techniques for incorporating nonmonetary value information into the decision making process. The *Valuation Procedures Manual*, therefore, will complement and support the process described in the *Cost Effectiveness/Incremental Cost Analysis Manual*.

Trade-Off Analyses

As explored in the *Case Studies* report, restoration projects often have multiple objectives and multiple stakeholders. The restoration planning process must balance these competing interests. In the *Trade-Off Analysis* report, alternative techniques to trade off competing interests are assessed. They include quantitative approaches such as multiobjective analysis, conflict analysis (a subset of game theory), and small group processes.

As suggested by previous discussions of small group processes for stakeholder involvement, there are opportunities for trade-off analysis throughout the planning process. In the Comparison of Plans step there are opportunities to utilize the trade-off techniques of multiobjective planning and conflict analysis. Multiobjective analysis (MOA) consists of a family of techniques to optimize operation of a system to accomplish multiple goals. The classic example of MOA trade-off techniques is the optimization of the operations of multipurpose reservoirs within a given river basin. MOA would be appropriate for the comparison of alternative restoration plans that have multiple objectives, such as a wetland restoration project that has flood control benefits, recreation, and restoration objectives. Conflict analysis is game theory applied to planning situations. A quantitative modeling of conflict between multiple parties can be developed using a game-theoretic structure. The model is based upon each party having a limited number of options available to pursue their interests. Conflict analysis can be used to identify solutions that are satisfactory to all parties — solutions that may be hidden by misunderstandings between parties or because values or options were concealed.

It has been noted throughout this report that there are significant qualitative issues that affect environmental planning. The *Group Process* report provides tools for the comparison of alternative plans. The information generated through these activities can also be used to support the plan selection process in Step 6.

Uncertainty Issues in Plan Comparison

A comparison requires some criteria upon which it will be based. If the criteria are uncertain (e.g., due to the relative weights different stakeholders give to different outputs) or are not known to decisionmakers, there is a potential for considerable misunderstanding and error in the decision process. Again, the *Introduction to Risk and Uncertainty* covers these sources of uncertainty. A systematic approach for addressing these uncertainties will be presented in *Procedures Manual: Risk and Uncertainty*.

Decision Support System

The ability to compare multiple alternatives and to identify differences between plans will be improved through use of the Integrated Bio-Economic Planning System (IBEPS). IBEPS incorporates restoration engineering and management measures with HEP evaluations of the management designs. Cost effectiveness evaluations, incorporating *Eco-Easy Software*, utilizes the HEP analyses to generate incremental cost evaluations of the restoration designs, as described in *IBEPS Development* and *IBEPS Implementation*. The *IBEPS Software* enables the planner to incorporate habitat, engineering measures, and cost effectiveness information in a single database. This capability allows and supports "what if" scenarios, readily enabling the reformulation of alternatives to see how HEP and cost effectiveness measurements change in response to changes in the engineering and management measures used in an alternative.

Results of This Step

The Comparison of Plans step identifies and weighs the differences between alternative restoration plans. In the application of cost effectiveness analysis to restoration projects, the Comparison of Plans step develops the incremental cost curve for a range of restoration alternatives. This incremental curve is carried forward to the final planning step, Plan Selection.

STEP 6: PLAN SELECTION

The final step in the *P&G* six-step planning process is Plan Selection. In this step, a recommended plan is selected from among feasible alternatives. By this point in the planning process, all nonfeasible alternatives should have been eliminated. The selection of a recommended plan is based upon the comparisons of quantitative and qualitative information generated by the previous planning activities.

The comparisons of plans in the preceding step do not automatically lead to an obvious decision about a recommended restoration plan. The analyst's role is to provide information and advice on a recommended plan. The results of the planning process are typically presented to other parties who collectively generate a recommendation. These other parties include Corps higher authorities, other Federal agencies, non-Federal project partners, project stakeholders, and the general public.

The selection of a recommended plan for restoration projects can be much more challenging than for traditional water resources development projects. The absence of an NED alternative makes plan selection much less certain. The predominance of nonmonetary benefits encourages the use of cost effectiveness analysis, which typically do not identify an optimum project configuration as in the case of cost-benefit analysis. Finally, project stakeholders often have predetermined concepts

of project scale, scope, and design, making it difficult to develop a consensus around a given restoration alternative.

The issue of uncertainty arises in this step of the planning process as well. All of the sources of risk and uncertainty encountered in the study become cumulatively and hopelessly hidden from the view of decisionmakers unless there has been a systematic attempt to address risk and uncertainty throughout the planning process. Potential methods of addressing these concerns are provided in *Introduction to Risk and Uncertainty*, while the *Procedures Manual: Risk and Uncertainty* contains a systematic outline for incorporating risk-based analysis throughout the planning process.

Restoration Plan Selection

As discussed previously, the restoration guidance EC 1105-2-210 recognizes the predominance of nonmonetary benefits and identifies cost effectiveness and incremental cost analyses as tools that can be used to support investment decisions for restoration projects. The inability of cost effectiveness analysis to identify an optimum project from among the alternatives places additional importance on Corps coordination with local project partners, other stakeholders, and the general public.

There are also internal challenges in the plan selection process within the Corps. Internal reviews of Corps planning proposals traditionally begin with the NED plan, and departure from this plan requires compelling reasons. The absence of a defined starting point for the internal review up through the Corps hierarchy can inhibit a consensus regarding the comparison of alternative plans and the Corps recommendation of a restoration alternative.

EEIRP Planning Support: Restoration Plan Selection

The process of selecting a recommended restoration plan is the culmination of the planning process as well as the ultimate focus of the EEIRP. In general, all of the EEIRP products that support the various planning steps have been oriented toward efficiently and effectively selecting a recommended plan. However, the EEIRP products that explicitly support plan selection activities are those regarding incremental analysis, decision support systems, stakeholder participation, and Corps internal coordination.

Cost Effectiveness and Incremental Cost Analyses

The *Procedures Manual: Cost Effectiveness and Incremental Cost Analyses* and *Eco-Easy Software* contain guidelines that can help in interpreting the analyses' results for plan selection. In

place of the traditional plan selection rule — to select the "NED plan" — making selection decisions among environmental alternatives is guided by the question "Is it worth it?" The results of cost effectiveness and incremental cost analyses - displayed as graphs of outputs against costs — permit decisionmakers to progressively compare increasing levels of environmental outputs and ask if each successive level is "worth it" - that is, is the additional environmental output in the next level worth its additional monetary cost? The procedure suggests several decision-making guidelines that may be helpful, including output targets, minimum and maximum output thresholds, maximum cost thresholds, breakpoints, data uncertainty, and unintended effects. Although neither cost effectiveness nor incremental cost analysis will usually result in the identification of a single best alternative, they will result in more informed decision making for environmental restoration and mitigation.

Stakeholder Participation in Plan Selection

The selection of the recommended plan is a joint decision between the Corps and the local project partners, often with substantial input from project stakeholders and the general public. While this is generally true for traditional water resources development projects, the absence of a unique, optimal restoration plan, such as the NED alternative, can place significantly greater emphasis on stakeholder coordination in restoration planning. The EEIRP has devoted considerable attention to stakeholder input to the planning process through small group processes.

Decision making with small groups is discussed in multiple EEIRP products. As explored in the *Stakeholders* report, small group techniques that are used for decision making are particularly relevant for plan selection. In the *Valuation Review* report, the absence of monetary benefits led to recognition that close coordination with project stakeholders is needed to select a restoration plan and that small group techniques can lead to agreement on plan selection. Both the *Group Process* and *Trade-Off Analysis* reports describe alternative group techniques that can be used to make decisions. Depending on the makeup of the group and the issues involved, there are many small group techniques that can aid decision making.

Decision Support System

In support of documenting the plan selection process, the *IBEPS Software* produces GIS maps and analyses as well as tables and other summary data showing the HEP and cost effectiveness information for the alternatives under consideration. *IBEPS Implementation* provides an example of the evaluative information that can be produced by the system.

Internal Coordination With Higher Authority

The evolving nature of the Corps restoration mission and the absence of monetary benefits add significant subjectivity in the plan selection process. As discussed in the *Case Studies* report, this subjectivity has resulted in different perspectives within and between the different hierarchical elements of the Corps. Districts may select one plan for recommendation; Divisions and Headquarters might select others. This internal uncertainty can create inefficiency and ineffectiveness not only on the part of the planning team, which may be unsure of the requirements of higher authorities, but for the organization as a whole with respect to communication within the hierarchy.

Results of This Step

Assuming that the No-Action alternative is rejected, the plan selection process will result in a recommendation to Corps higher authority and/or Congress for authorization to implement the plan. The planning process might still be far from complete. The process is iterative. Depending on the type of project authority, there may yet be multiple iterations through the sequence of six steps of the *P&G* planning process.

PORTFOLIO-SCALE RESOURCE ALLOCATION

From the beginning of the EEIRP, the objectives of the program have been to address the site and portfolio questions introduced at the beginning of this report. Regarding the site question, the program has endeavored to retain flexibility in planning to creatively select the "best" restoration plan in terms of the environmental objectives and constraints. Regarding the portfolio question, the EEIRP has promoted the use of consistent and effective methodologies for all Corps restoration planning in order to efficiently allocate resources nationwide.

Many of the site and portfolio considerations for restoration planning are longstanding issues for traditional water resources planning. For water resources development and restoration projects, an appropriate balance of these considerations would be most desirable. Specifically, the goal would be to retain creativity and flexibility at the site level with some measure of consistency supporting portfolio decisionmaking without excessive losses in planning efficiency and effectiveness.

For restoration projects, these common decisionmaking factors are compounded by the difficulty in evaluating their nonmonetary benefits. One of the resonant themes of this report has been how the absence of a common metric for evaluating the benefits of alternative plans complicates the selection of the "best" plan. This challenge is magnified at the portfolio scale of analysis, when comparisons between projects with completely different nonmonetary benefits must be made.

The portfolio challenges of restoration projects are not insurmountable. Several products of the EEIRP are particularly pertinent to portfolio decisionmaking. First, the significance of the resources of the alternative sites, encompassing institutional, technical, public, and cultural resources, must be clearly identified for portfolio analysis. The reports *Significance: Resource Document* and *Significance: Protocols* can be used to determine the level of Federal interest and will guide the project's priority of Federal action. Second, the cost effectiveness and incremental cost analyses products can be used to apply the "Is it worth it?" question to alternative plans and aid in portfolio decisionmaking. Third, the *Linkages* report can be used to identify and compare socially valued goods and services (i.e., benefits) associated with the different "best" plans from around the country. Finally, portfolio decisionmaking can be supported by comparing the combinations of the above quantitative information with other project information, such as stakeholder input. The *Stakeholders* report may be particularly helpful in synthesizing quantitative and qualitative information.

IV. SUMMARY

CHALLENGES OF THE CORPS RESTORATION MISSION

The evaluation framework for Corps restoration projects is the same as for traditional water resources development projects, the six-step planning process of the *P&G*. However, restoration projects pose unique challenges to this process. As evidenced throughout this document, restoration projects have important differences from traditional water resources development projects, most notably the nonmonetary benefits. In response to these challenges, the Corps has made several initiatives to facilitate the interpretation of the *P&G* for application to restoration projects. These initiatives include the draft restoration guidance EC 1105-2-210 and the EEIRP.

ROLE OF THE EEIRP

The EEIRP was designed to assist Corps environmental planners with the site and portfolio questions regarding restoration projects. This program has been developing a variety of research products that support critical planning activities in each of the six planning steps. These products have broad applicability to environmental issues in the Corps, beyond those of restoration planning. The EEIRP products to date have direct significance for restoration planning. However, these products with direct relevance for restoration planners (rather than background research) should be disseminated to field offices. As the research continues, the products of the different work units will continue their convergence, and the ongoing development of procedures manuals for the various planning activities will directly support current restoration guidance.

APPENDIX A

ANNOTATED BIBLIOGRAPHY

ANNOTATED BIBLIOGRAPHY OF EEIRP PRODUCTS

An Introduction to Risk and Uncertainty in the Evaluation of Environmental Investments

Incorporating risk and uncertainty into environmental restoration planning studies can be a means of improving the quality of the decision-making process. This report introduces Corps personnel involved in the planning of environmental restoration projects to the basics of risk and uncertainty analysis. The taxonomy of terms described in this report provides the new risk analyst with a way to think about the knowledge, model, and quantity uncertainty that is present in environmental planning. Selected tools and broad concepts are introduced as a means of addressing these uncertainties. In addition to generic, "big picture" sources of uncertainty related to the Corps six-step planning process, uncertainties specific to environmental planning are identified. Common potential sources of uncertainty include delineation of the study area, identification of target species, the structure of habitat suitability index models, habitat variable measurements, calculation of existing and future habitat units, and modeling project performance using habitat evaluation procedures. An example introducing risk-based analysis to the estimation of habitat unit changes is offered to demonstrate the feasibility of some of the methods presented in the report.

Compilation and Review of Completed Restoration and Mitigation Studies in Developing an Evaluation Framework for Environmental Resources, Volumes I and II

Corps Districts are being faced with servicing the present environmental needs of their constituencies. This is being met with varying degrees of success from the perspectives of the Corps planner and local interests. Monitoring the recent past and real-time environmental endeavors of the Corps reveals that, although there are management challenges in the planning arena, some successful techniques are emerging. This two-volume set describes important environmental restoration and mitigation planning issues currently facing Corps planners. Findings are based on ten (10) Corps field case studies, including interviews of both Corps and non-Corps study team members, and a focus group session conducted with Washington-level reviewers. Volume I includes a description of the research approach and findings and recommendations for future research. Detailed summaries of the focus group session and the individual case study interviews are in Volume II.

Development of an Integrated Bio-Economic Planning System for Corps of Engineers' Planning Projects: Conceptual Design

In the environmental planning realm, U.S. Army Corps of Engineers planners are frequently asked to assist in the design of restoration projects, as well as assess potential impacts of projects/programs, and suggest cost-effective and biologically productive compensation/mitigation solutions for impacted areas of concern. To accomplish these tasks, planners must have direct access to the necessary data (spatial inputs/outputs, and costs for the potential development management measures) to aid in the selection of cost-effective solutions during the plan formulation process of project design. The Walla Walla District Corps of Engineers has developed a conceptual design for an Environmental Decision Support System (EDSS) that would give planners the ability

to design multiple management scenarios and assess the biological outputs associated with each scenario in a "user-friendly" environment. The EDSS would also allow comparisons of multiple scenarios and combinations of scenarios using a cost-effective and incremental cost strategy. Four major components would be combined to produce the EDSS: 1) spatial information and analyses, 2) environmental benefit and cost evaluations, 3) incremental cost and cost-effective analyses, and 4) multiple management design analyses.

Environmental Valuation: The Role of Stakeholder Communication and Collaborative Planning

This report describes how understanding the perspectives of stakeholders in USACE environmental projects can improve the identification and communication of project benefits. Valuation of project features is a central component of the Corps decision-making framework. This report is based, in part, on three case studies of current USACE environmental projects as well as interviews with USACE Headquarters personnel involved in making policy or reviewing environmental projects. The goal of the interviews and meetings was to better understand project priorities from individual stakeholders and to observe the discussion of selected issues by the stakeholders.

Evaluation of Environmental Procedures Manual Interim: Cost Effectiveness and Incremental Cost Analyses (includes accompanying software)

The cost effectiveness procedures manual was developed to serve as a practical guide for applying and interpreting cost effectiveness and incremental cost analyses for comparing the effects of alternative environmental restoration and mitigation plans. It describes the data requirements for analyses, step-by-step instructions for conducting the analyses, examples of the application in different planning settings, decision making using the results of analyses, case studies, exercises, and instruction in the use of the program, ***ECO-EASY: Cost Effectiveness and Incremental Cost Analyses Software***. The ***ECO-EASY*** software was developed to perform the routine, and often time-consuming, "number crunching" required by the analyses; freeing planners to focus on the identification of solutions, the estimation of their environmental and economic effects, and the communication of information to support decision making. Both the manual and the ***ECO-EASY*** software include a module to assist with plan formulation, where individual management measures and their inter-relationships are identified and combined into all alternative combinations of measures. Additionally, there are guidelines that assist in interpreting and using the results to make decisions.

Linkages Between Environmental Outputs and Human Services

This report identifies relevant socioeconomic use and nonuse values associated with environmental projects. It also indicates the linkages between environmental output measures and necessary inputs for socioeconomic evaluation. It answers the question: What are the possible changes in the ecosystem that may result from USACE environmental mitigation and restoration projects, and what outputs and services do these changes provide society? The report includes a

series of tables which link USACE management options, ecological inputs, ecological outputs, and human services. Also, indirect effects of management options are identified.

Monetary Measurement of Environmental Goods and Services: Framework and Summary of Techniques for Corps Planners

Many techniques exist that are designed to express the value of environmental goods and services in a monetary metric. However, most of these tools are described in very broad terms in economic textbooks, and in very technical terms in economic journals, leaving a gap which often makes the techniques difficult for potential practitioners to understand. The purpose of this report is to provide guidance for selecting an appropriate monetization technique for environmental project planning - one that is both consistent with the question being addressed and the resources available to perform the study. For six of the most common techniques, the following information is provided: the theoretical basis for the technique, application issues, resource requirements, and a list of selected references. The six techniques covered in the report are: the contingent valuation method, hedonic pricing methods, travel cost methods, income measurement, the replacement cost approach, and benefits transfer.

National Review of Non-Corps Environmental Restoration Projects

This report has compiled and compared management measures, engineering features, monitoring techniques, and detailed costs for a representative sample of non-Corps environmental projects or engineering projects (39) with environmental features. This report is part of the series of reports that will be used to develop the ***Prototype Information Tree for Environmental Restoration Plan Formulation and Cost Estimation*** report. The projects are categorized into 16 types, based on the projects' primary features. These types are: 1) bottomland hardwood forest restoration, 2) enhancement of fish and wildlife habitat, 3) estuarine wetland creation, 4) estuarine wetland enhancement, 5) estuarine wetland restoration, 6) estuarine wetland restoration and wildlife enhancement, 7) mitigation bank establishment, 8) stream enhancement, 9) stream restoration, 10) water quality remediation, 11) wetland creation, 12) wetland creation and enhancement, 13) wetland enhancement, 14) wetland mitigation, 15) wetland restoration, and 16) wetland restoration and enhancement.

Prototype Information Tree for Environmental Restoration Plan Formulation and Cost Estimation

This is the first of a series of reports that investigates the possibility of developing an informational tool for organizing and providing the type of data and information necessary for identifying and costing environmental restoration measures. It describes the conceptual development of an information tree to assist in the design of environmental restoration projects. The report focuses on three specific objectives: 1) develop a prototype information tree structure to organize data and information useful for environmental restoration plan formulation and cost estimation; 2) describe the content of the tree branches and their linkages; and 3) begin the process of building the tree database, identifying additional data sources and data deficiencies with respect

to its more complete implementation. This report: 1) identifies the environmental variables that need to be manipulated to promote project goals (i.e. target variables); 2) links target variables with broad management approaches that could be used to manipulate them; 3) links broad management approaches with more specific management measures and techniques for their implementation; 4) identifies the major engineering features or components associated with alternative management techniques; and 5) provides information that will help project planners estimate the costs of management techniques. It will also identify their potential effectiveness, and any ancillary effects.

Resource Significance: A New Perspective for Environmental Project Planning

Resource significance is one metric that can be used in the selection and prioritization of environmental projects for implementation. This report provides a brief discussion of the concept of resource significance in terms of institutional, public, and scientific or technical criteria. It provides a summary of 95 existing programs that have been developed for purposes of ranking projects, with more detailed summaries of selected programs that assist in determining environmental significance. Included in the review are examples of Federal, regional, state, and nonprofit programs and programs for historical properties.

Review of Monetary and Non-Monetary Valuation of Environmental Investments

Placing value on the environment, whether through monetary-based methods or through other valuation techniques, has been and will continue to be a widely debated topic. The conceptual foundation and institutional setting for pursuing further study of valuation approaches are developed in this report. Specific objectives are to: 1) describe services provided by environmental resources and systems, 2) identify methods for the measurement or valuation of environmental resources; 3) review existing research programs and products; and 4) evaluate the resource constraints on potential Corps' field applications. Independent expert views from an economist, engineer, ecologist, and psychologist pertaining to environmental outputs and valuation techniques are included as appendices.

Trade-Off Analysis for Environmental Projects: An Annotated Bibliography

Trade-off analysis is composed of many tools for identifying optimal solutions to complex problems. Tools must be appropriate to the specific context. In some circumstances, a single evaluation technique may be appropriate; in others, combinations may be most effective. This study explores the literature for analytical techniques that can support the complex decision-making process associated with Corps environmental projects. The literature review focuses on opportunities for using trade-off methodologies and group processes in environmental plan formulation and evaluation. An annotated bibliography is included.

Trends and Patterns in Cultural Resource Significance: An Historical Perspective and Annotated Bibliography

This report offers a broad, analytical review of the literature concerned with the challenging subject of evaluating cultural resource significance. The review of significance includes two main sections: (a) an Annotated Bibliography (consisting mostly of peer-reviewed literature) and (b) an Analysis Section (devoted to tracing historical trends in archaeological method and theory). The literature summarized is extensive and is not readily accessible to the archeological and cultural resource management (CRM) communities. After analyzing a wide range of publications, 21 major themes and/or concepts were established to characterize the breadth of archaeological views and ideas about significance. A review of each theme was undertaken, including a discussion and a graphical presentation of trends through time. Systematic indexing and cross-referencing of publications, authors, and significance themes have also been carried out to assist users in locating references of special interest. The concluding section offers some suggestions and insights into the future direction of significance evaluation with respect to the work unit and within CRM generally. Particular emphasis is placed on the opportunities for developing more holistic management strategies, making greater use of new approaches and technologies, and using more explicit evaluation methods.

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13. ABSTRACT *(Maximum 200 words)*
This report is to support Corps planners by identifying EEIRP products that can be used to apply the P&G planning process to environmental projects. Underlying the incorporation of the EEIRP products in the P&G planning process is the need to 1) integrate the tools and techniques identified and developed by the EEIRP and 2) ensure that they collectively address the site and portfolio questions. (NOTE: Not all of the EEIRP products have been completed. This interim report highlights the finalized products and outlines those that are in progress. Once all of the products have been completed, this report will be updated and finalized.

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